# JUNEAU ICE FIELD RESEARCH PROJECT

## 1951 WINTER SEASON

By

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Department of Exploration and Field Research
American Geographical Society
Broadway at 156th Street
New York 32, N. Y

J.I.R.P. Report No. 8

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## FOREWORD

This is another in the series of reports being assembled for each field season of the Juneau Ice Field Research Project which has been continued under the sponsorship of the American Geographical Society through contract (Task Order N9onr-83001) with the Office of Naval Research. This project, in addition, has received supplies and field support from the Departments of the Army, Navy and the Air Force, and from other governmental and private agencies.

The primary purpose of the 1951 winter expedition was to extend the glaciological and meteorological investigations of the previous summer seasons with special emphasis on studies of the winter environment. A description of the research techniques employed and a presentation of the basic information obtained are given in the following pages. Some preliminary interpretations have been made; however, the essential objective of this report is to make the significant data available, leaving the full analysis for a later date.

Grateful acknowledgement is given to my wife, Joan, for typing and editorial assistance in the preparation of the manuscript. Acknowledgment is also made of the drafting services of Jean Tremblay and Leslie Thurston.

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## I. INTRODUCTION

Under the auspices of the American Geographical Society, an eight-man party occupied two main camps of the Juneau Ice Field Research Project in the Taku River district of Southeastern Alaska (Figures 1 and 2) from January 26 to February 26. This expedition was carried out under contract with the Office of Naval Research (Task Order N9onr-83001) and had the cooperation and active support of the Departments of the Air Force and Army, the U. S. Forest Service, and a number of other civilian and government agencies.

The Juneau Ice Field Research Project was organized as a long-range, integrated scientific study of the Juneau Ice Field. Detailed investigations were initiated in 1948 and continued in the summer seasons of 1949 and 1950. The primary purpose of the 1951 winter expedition was to extend the glaciological and meteorological research program. Specifically, it was planned to gather information on the mid-winter climatological character of the ice field, with emphasis on surface regimen and englacial temperature conditions at that time of year. In addition, some mid-winter observations of current interest to glaciologists were planned concerning certain fundamental problems in the metamorphosis of snow and in the internal structure and movement of glaciers.

Data were obtained so that when correlated with observations from other seasons of the year they would provide a firmer basis for evaluation of the Taku Glacier's annual and long-range budget. Information was also gathered to help in the practical planning of future operations on the Juneau Ice Field during the colder months of the year and to point the way to formulating a more comprehensive scientific program in subsequent winter seasons.

## II. PERSONNEL

In addition to the six civilian members of the field party, two experienced weather observers from the U. S. Air Force Arctic Weather Central in Anchorage were invited to join the project. The following men made up the roster of personnel. The figure in parenthesis after each name indicates the number of previous expeditions of the Juneau Ice Field Research Project in which each man had participated.

| | |
|---|---|
| M. M. Miller: | American Geographical Society, Project Director, glaciologist (3) |
| F. A. Small: | Goddard College, assistant glaciologist, field secretary (1) |
| Dr. T. R. Haley: | Flower Fifth Avenue Hospital, New York City, medical officer (1) |
| F. A. Milan: | University of Alaska, meteorologist, communications and over-snow vehicle mechanic (1) |
| A. W. Thomas: | U. S. Forest Service representative, logistics (3) |

Sgt. C. E. Anderson: U. S. Air Force representative, weather observer (1)

Sgt. A. Schneider: U. S. Air Force representative, weather observer

T. McCahill: pilot, liaison in Juneau

## III. OPERATIONS

The advance party arrived in Juneau on January 20th in order to assemble equipment and to make ready the oversnow vehicles. Small and Anderson were flown to the main camp on the ice field on January 26th in a light ski-equipped aircraft. They were followed in the next few days by the remaining members of the party. By February 3rd all personnel were on the upper Taku Glacier, and the field program was well underway. Two camps were re-occupied from the previous summer's network. These were Camp 10, the main research station on a rock island near the center of the ice field at 3,862 feet elevation and Camp 10B, a mile and a quarter out on the surface of the glacier at approximately 3,600 feet elevation.

From the standpoint of effective field operations, it was soon apparent that February meteorological conditions produce a characteristic arctic regime on the higher reaches of this ice field. The rapidly changing nature of the snow surface due to snowfall, compaction, wind drift and corrasion, was an impressive contrast to that of the summer months. The minimum temperature experienced at the winter camps during this period was 30° below zero Fahrenheit (-34.4°C.) with winds on some occasions reaching 70 miles per hour in prolonged gusts. One stretch of blizzard weather lasted ten days, during which time the tents of the upper Taku Glacier camp were buried in at least 72 inches of new, dry powder snow. The first two weeks of February were continuously clear, although temperatures remained consistently well below zero. The dry cold associated with these clear skies was never so frigid (even at -25°F.) that work could not be carried on outside.[1] The basic weather records at each camp provide a useful comparison with those maintained at the same time at low level stations in Juneau and at mining camps on the east side of the ice field.

The well-insulated cabin at the research station provided comfortable headquarters. Double-walled, hexagonal tents, being tested for the Army Quartermaster Corps at the glacier camp, were also quite satisfactory. When a Coleman gasoline heater was used in these tents, the inside of the outer walls would become sheathed with ice and transform the structure into a veritable igloo. At the top of the tent, temperatures would reach 90 or more degrees above zero (F.) in contrast to the temperatures of 10 to 30 below zero outside. A large igloo was constructed at the glacier camp for the storage of gasoline and supplies flown in on the ski plane.

[1]This would probably not be true in more northerly and more continental climates during the same months of the winter. It emphasizes the value of this region as a winter test area and scientific field laboratory, since in more severe cold such outside work must often be curtailed.

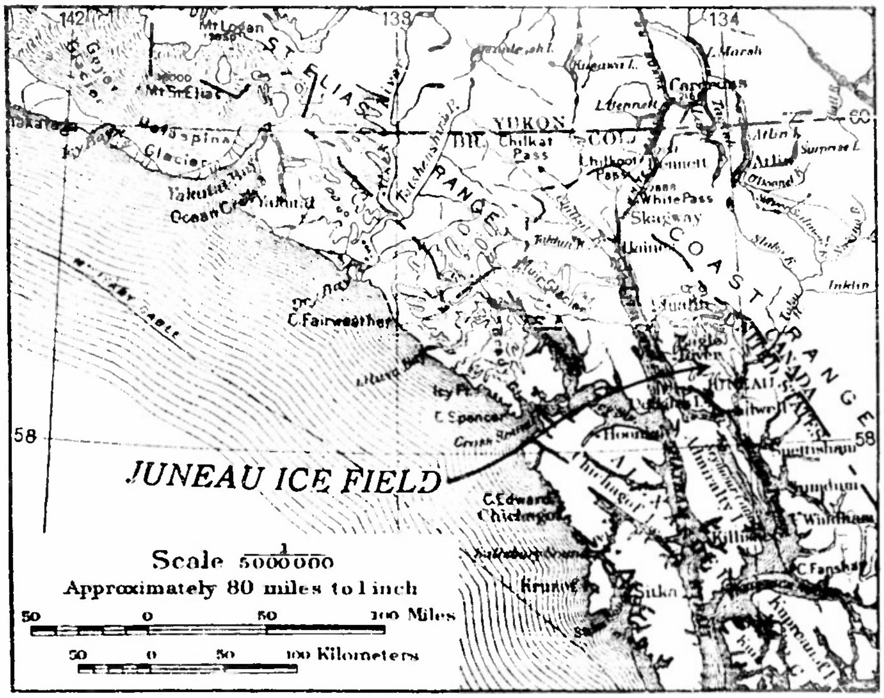



Fig. 1. Location map of the Juneau Ice Field in Southeastern Alaska. Modified from the U. S. Geological Survey's "Alaska" Map A, 1:5,000,000.

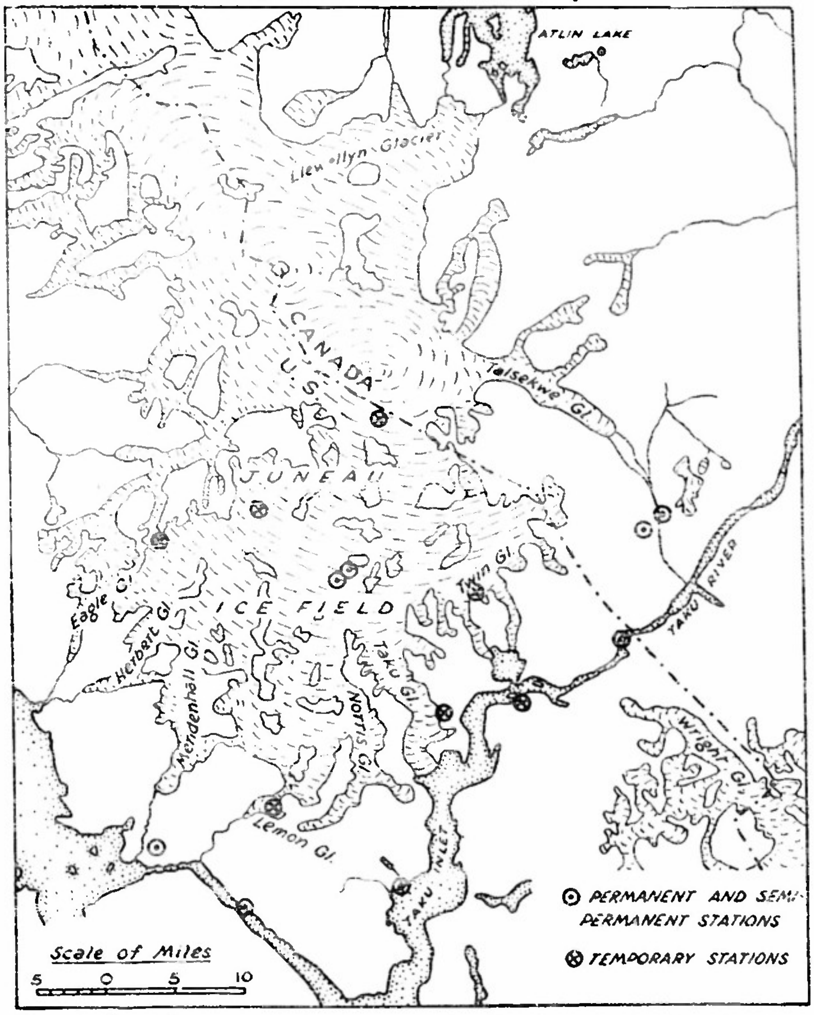



Fig. 2. Sketch map of the Juneau Ice Field and vicinity showing meteorological stations.

No travel was undertaken to other localities on the ice field, since the investigations were largely detailed and "laboratory" in nature and could be conducted at the two main camps. The expedition was fortunate in having the use of a 160 H. P. ski-equipped Aeronca Sedan which was employed for all logistic support. During the course of the 32 days that the party was in the area, this aircraft made 19 round trip flights from Juneau to the ice field, combining most of them with one or more ski landings. Several reconnaissance flights were also made to other localities to assess their winter conditions for possible future travel and potential winter field work.

Insufficient depths of new snow on the lower Taku and Norris glaciers precluded fulfillment of original plans to drive the expedition's two over-snow vehicles (Army M29c "weasels") to the main camp by an overland route from tidewater. Delivery of these vehicles to the ice field was therefore postponed until the following summer in anticipation of sufficiently heavy spring snows filling in the crevasses at lower levels and eventually making the overland passage practicable. This did not prove feasible, however, and the "Weasels" were parachuted into the area in July 1951.

Evacuation of all personnel and records from the ice field was planned for the end of February, and to facilitate this an Air Force ski-wheel C-47 from the 10th Air Reucue Squadron arrived in Juneau on February 20th. Four days of blizzard weather and deep fresh snows prevented the landing of this aircraft on the glacier. It returned to Anchorage on the 23rd for an engine check-up and was to stand by for a flight back to Juneau on the next clear day to effect the evacuation. Further storm warnings, however, posted along the coast on the morning of February 26th, augured to close in the area for another indefinite period. Therefore, taking advantage of a short lull before this next storm, the ice field party made radio contact with the project's liaison in Juneau. Arrangements were made with the expedition's local pilot to make six emergency flights with his small ski aircraft to evacuate all personnel. This was successfully accomplished the afternoon of February 26th, just before the expected storm broke and precluded further flying for some days.

## IV. SCIENTIFIC PROGRAM

The essential objectives of the winter program were glaciological and meteorological. Continuous hourly synoptic meteorological records were maintained at the two camps during the month of February. These were supplemented by records of duration of sunshine and of thermal values of incoming solar and sky radiation obtained by the use of a Campbell-Stokes sunshine recorder (British M. O. Pattern) and an Eppley 50-junction pyrheliometer with attached Brown recorder.

The 46-foot aluminum tower, erected at Camp 10B during the summer of 1950, was found bent over at right angles by heavy autumn snows which created undue pressure on its guy ropes. The tower was spliced and re-erected. Upon it was placed a string of thermocouples (thermistor elements) for air temperature readings up to 30 feet above the mid-February snow surface. This, it was hoped, would provide further information on the katabatic air layer which is such a prominent feature of this area of highland ice during the winter months.

Readings on three sets of englacial thermistor cables were made for the purpose of recording temperatures to a depth of 170 feet. In addition, periodic profiles of the physical characteristics of the snow-pack were made along the walls of pits dug at Camp 10B in order to obtain density, hardness, crystal grain size and compaction data in the layers of snow which had fallen since the end of the 1950 ablation season. Samples for the quantitative determination of chloride content were taken at selected levels in these pits. This was done in order to supplement the laboratory analysis being made by H. Kothe, of the 1950 expedition, and by the U.S. Geological Survey on samples collected during the previous August.

Of special interest was the alignment survey of the 245-foot aluminum pipe which had been left in one of the vertical holes bored by core drilling the previous summer. In this work a specially designed azimuth-inclinometer, with attached recording camera which could be preset by clockwork, was used. Several surveys were made during February at 20-foot intervals inside the pipe to determine its deformation. A comparison of three different periodic surveys of this pipe provides a basis for estimating the vertical velocity profile of ice flow at depth. The first survey was achieved in August, 1950 when the pipe was implanted, the second during the winter expedition, and the third during the summer of 1951. By transit and theodolite, data were obtained for the calculation of the surface movement of the glacier at this site during the February period and also for the time elapsed since summer.

In the following pages details of the meteorological program are presented and the results and records of the glaciological work are listed and, in part, discussed. The shortness of the 1951 mid-winter observation period makes it advisable to refrain from drawing certain conclusions until additional supplementary information can be integrated from field data of later seasons. In some cases, however, provisional conclusions are warranted and are therefore given. In addition, some of the more pertinent techniques and procedures for obtaining the scientific data are described. The factual information presented, in some cases, is in as complete a form as was possible to obtain it under the circumstances of field operation. In most cases, however, only the monthly summaries are tabulated in the Appendix, with the more detailed records (as hourly synoptic meteorological data) being on file and available at the American Geographical Society and at the pertinent weather stations in Alaska. Details of the procedures and logistics of this expedition and reports on the food, equipment tested and medical aspects are presented in other publications.[2]

[2]See Haley, T. R., Marcus, M., Miller, M. M., and Small, F. A., "Food Reports Juneau Ice Field Research Project, Alaska, June 1949 to February 1951", J.I.R.P. Report No. 3, Am. Geog. Soc., New York, May 1951, pp. 31-39; Haley, T. R., McCollester, D. L., and Nicholl, W., "Medical Reports, Juneau Ice Field Research Project, Alaska, June 1949 to February 1951", J.I.R.P. Report No. 4, Am. Geog. Soc., New York, June 1951, pp. 33-38; Miller, M. M., "Progress Report of Logistical Operations, Juneau Ice Field Research Project, Alaska, 1949, 1950, and 1951", J.I.R.P. Report No. 5, Am. Geog. Soc., New York, October 1951.

A. METEOROLOGICAL

The meteorological records obtained will be of considerable significance in the long-range climatological study when correlated with those from nearby sea-level and radiosonde stations and compared with seasonal records from other years.[3] Thus, emphasis was placed on obtaining records as complete as possible. To this end, the advance party began hourly standard weather observations at Camp 10 immediately upon arrival on January 26. At this main base, records were maintained for a full month until February 26th when the party evacuated the station. To supplement these, hourly synoptic meteorological records of even more detailed nature were maintained at Camp 10B. At both stations, diurnal surface weather observations on an hourly basis were continued from 1700 until 2200. For a short period, these observations were made on a full 24 hour basis, with three-hourly synoptics taken between 2200 and 0700. The following data were included: ceiling in hundreds of feet, percentage of overcast, visibility, sky condition (the weather and/or obstruction to vision), barometric pressure in millibars, temperature and dew point, wet and dry bulb temperature readings, wind direction (velocity and character), cloud description and amount, type, height, and direction, precipitation (only as snowfall), and maximum and minimum temperatures for every six hours. To supplement this standard meteorological record, remarks were noted concerning the snow surface character, and daily records of continuous solar and sky radiation were made. A continuous record was also maintained of the periods and duration of sunshine.

1. Synoptic Weather Records at Occupied Stations on the Ice Field

Details of the synoptic weather record for Camps 10 and 10B on the upper Taku Glacier are included in Appendices A(1) and A(2). Appendices B, C, D, E, and F include simultaneous records of meteorological conditions at four low level stations adjacent to the ice field; one at the Juneau Airport, another in the city of Juneau, a third at Annex Creek in Taku Inlet, and a fourth station situated at Big Bull Mine in the valley of the Talsekwe River near Tulsequah, British Columbia (Fig. 2). The maximum and minumum temperatures at Camps 10 and 10B are listed below for the period January 27 - February 26. From these it may be seen that continuously sub-freezing conditions were encountered by the field party.

| Dates | Camp 10 | | Dates | Camp 10B | |
|---|---|---|---|---|---|
| 11, 15, 16 Feb. | Max. Temp. | 25°F. | 15,21 Feb. | Max. Temp. | 29°F. |
| 5 Feb. | Min. Temp. | -11°F. | 4 Feb. | Min. Temp. | -30°F. |
| Jan.-Feb. period | Av. Temp. | 12.4°F. | Feb. 10-23 period | Av. Temp. | 12°F. |

[3] For comparative locations of stations, see Figure 2.

The following comparative summary is also listed for convenient and ready reference to the period January 27 - February 28. These data are taken from the monthly records of conditions at the two camps, from those of the Juneau Airport Station of the U. S. Weather Bureau on the southwest side of the ice field, and from the Annex Creek and Big Bull Mine records obtained on the southern and eastern sides of the ice field. (See Appendices and Fig. 2)

| | Camp 10 | Camp 10B | Jun. Airp't | Annex Creek | Big Bull Mine |
|---|---|---|---|---|---|
| Elevation of station (feet) | 3862 | 3600 | 24 | 20 | 300 |
| Max. wind velocity (m.p.h.) | Est.70 | 20 | 31 | -- | -- |
| Average relative humidity (per cent) | neg. temps. | | 78 | -- | -- |
| Usual wind dir., clear weather | N | | -- | -- | -- |
| Usual wind dir., stormy weather | S.E., E.S.E. | | -- | -- | -- |
| Number days clear (scale, 0-3) | 5 | | 6 | -- | -- |
| Number days partly cloudy (scale, 4-7) | 7 | | 4 | -- | -- |
| Number days cloudy (scale 8-10) | 18 | | 23 | -- | -- |
| Total precipitation during Feb.(in.$H_2O$) | 4.16 | 8.04[4] | 2.31 | 5.76 | 2.70 |
| Max. Temp. during period (F.) | 23 | 29 | 37 | 42 | 47 |
| Min. Temp. during period (F.) | -11 | -30 | -8 | -6 | -15 |
| Average Temp. during period | 12 | -- | 19.5 | 22.2 | 17.8 |
| Number days (Feb.) with sub-freezing temperatures | all | all | 25 | 25 | -- |
| Number days (Feb.) with Min. of 0° F. or below | 8 | -- | 8 | 2 | -- |

The carefully obtained synoptic record of temperatures taken by the Air Force meteorologists on each hour during the day was supplemented by continuous thermograph data at the two ice field sites. Thus, the periods between the hourly readings may be studied for purposes of micro-meteorological analysis. These data are of value particularly during twilight when large temperature changes occurred. They are also of value for study of the upper few feet of new snow and firn which would be influenced by variations in surface air temperature. In the discussion of the englacial temperature observations, the depth of seasonal stability maintained by the winter cold wave is indicated to lie roughly between the upper and lower limits of 13 and 65 feet below the February 21st reference surface level on the Taku Glacier. For further observations relating to an eventual analysis of these changes, one is referred to Part 8 in Section IVA of this report which deals with the three-hourly surface temperature records obtained from a thermistor cable (No. 151) on the antenna tower at Camp 10B. These data, supplemented by the summer (1951) micro-meteorological record, should be of use in interpreting the height and effect of the katabatic wind layer, as well as the effect of regional air flow, in the chilling of the glacier's surface.

[4] Largely by drifting (value reduced to approximate water equivalent).

2. Observing Procedures and Methods[5]

Meteorological observations at the ice field camps during the 1951 winter operation were taken in accordance with standard Air Weather Service methods employed by the Air Force Arctic Weather Central at Anchorage. Sgt. Calvin Anderson and Sgt. Adam Schmeider were assigned to the project from this organization for the full period in the field. These two men were experienced observers and one of them, Anderson, had been with the 1950 summer project on the Juneau Ice Field. During February, they were primarily responsible for the meteorological data obtained. The U. S. Weather Bureau WBAN Manual of Surface Observations, Circular N. 6th Edition of January 1949, was used as a procedural guide. Since with the exception of the pyrheliometer, no electrical apparatus was available for aiding the observations, the methods used were essentially of a field type.

The estimation of ceilings during the night are admittedly unreliable since aids such as pibals or ceiling lights were not available. Night time visibilities could only be safely estimated in clear and moonlight periods. For the estimation of daytime ceilings, the experience of the observers had to be relied upon. Cloud heights and visibilities at the glacier camp during a storm or blizzard were extremely difficult to judge. This was due to poor depth perception in low light and the fact that the nearest topographic features were at too great a distance to be of much value in this regard.

Wind velocities were usually estimated or mechanically recorded in miles per hour. A small hand anemometer was used at Camp 10B when occasions warranted. The instrument, to give reliable records, had to be employed with the greatest care, especially during periods of gusty wind and rapidly changing conditions. It was considered inaccurate primarily because the observer could not keep the instrument squarely faced into the wind during these extreme conditions. Thus, it was not always possible for him to catch the wind velocity at the peak of a gust. Such discrepancies could be remedied to a degree by a series of readings over a period of time. Unfortunately, this was usually impractical during good weather since then all personnel were using their time on other phases of the project. Another factor which reduced the chances for good anemometer readings in blizzard conditions was that the observer found it difficult to time the instrument properly because of hindrances from the necessarily heavy clothing worn and because of the driving snow. For these reasons, an automatic electrically operated recording device would be very useful when another team works at this camp in winter. With the installation of a large generator and its auxiliary at Camp 10 in the summer of 1951, there is now power available for the operation of such equipment. It is hoped that future records may have the benefit of such wind velocity and direction recording apparatus.

Temperatures for listing on the Weather Bureau AN forms were obtained from instruments enclosed and protected in standard shelters of the U. S. Weather Bureau type included in the U. S. Signal Corps Meteorological Set,

[5]The helpful assistance of Sgt. C. Anderson and Sgt. A. Schmeider is acknowledged in the initial preparation of this section of the report.

AN/TMQ-7. Psychrometer readings were taken in the open air, however, since the rotating axle and handle normally attached to such shelter screens were not provided. At Camp 10, the instrument screen was situated on an exposed outcrop on the top of a projecting buttress of bedrock 100 feet west of the cabin. It was securely guyed to the rock with rope and wire. Because this was such a wind-swept position, the shelter remained continuously four feet above its surrounding snow surface even during periods of heavy snowfall. A pile of rocks beneath the shelter which was also continually swept free by the wind may have introduced a minor radiation effect on the temperatures obtained at this station. Such errors, thus introduced, are undoubtedly small and unimportant in the over-all record.

At Camp 10B, located one and one-quarter miles south and west of the Camp 10 station, the screen rested directly on a sub-frozen snow surface of the Taku Glacier. Thus, rather different conditions existed here. The basal support for this shelter was anchored with its legs buried a foot under the snow and each leg packed as firmly as possible and well guyed to side stakes. This was satisfactory as far as stability was concerned. On several occasions, however, the shelter had to be moved to keep it from being completely buried under the increasing depth of freshly fallen snow. A sliding rack arrangement would have been desirable for maintaining constant height above the surface for all readings. As it was, the position of the instruments was at the snow surface during times of heavy snowfall. Then during periods of clear and cold weather, when the snow surface would settle and perhaps even be eroded by strong winds, the instruments would be as much as three feet above the snow surface. An effort was made to compensate for these differences. An instrument height of one and one-half feet above the level of the snow should be considered as an average. Temperature conditions at different heights up to 30 feet above the surface were recorded by other means (see Part 8 of this section).

As in any area where meteorological observations are made under sub-freezing conditions, difficulties were encountered in the determination of relative humidity. On many occasions, the water used for saturating the wicks of the wet bulb thermometers would freeze by the time an observation was to be made. At Camp 10B there was an additional problem. During periods of outside work on other phases of the field program, the stoves in the tents would be shut off. As a result, everything, including the water set aside for the psychrometers, would freeze. Since all members of the expedition cooperatively helped each other on the scientific program, at times there were no persons available to handle these more minor details. All dew point and relative humidity readings which could be obtained were converted with respect to liquid water according to the tables in Circular N. At both camps, water equivalent tests were made on freshly fallen snow, averaging a 1 to 10 ratio. These tests were carried out only on days when there was little or no wind and when the snow was accumulating rapidly. During blizzard conditions and periods of high wind, significant water equivalent tests were difficult to make because the presence of so much drift snow in the air caused measurements of true accumulation to be somewhat inaccurate.

Current meteorological data were radioed to the U. S. Weather Bureau in Juneau via the Civil Aeronautics Authority Radio Station at the city's airport. The schedule for this contact was 0900, 1200 and 2100 Pacific Standard Time. At these times, the observation taken a few minutes before was relayed. This information was forwarded to the Regional Weather Bureau headquarters in Anchorage and was of aid to the local Juneau Station, as well, in compiling its daily forecasts. Additional observations were transmitted at selected times during the day or night, if the supporting ski plane was to make landings or if other flight operations were anticipated in the area.

3. Total Sky and Solar Radiation Records

Measurements of total sky and solar radiation were unfortunately not as complete as anticipated due to a breakdown of the generator supplying electrical current to the Eppley 50-junction pyrheliometer and its attached Brown recorder. During the previous summer, several months of continuous pyrheliometer records were obtained so that a useful comparison of summer and winter data may be possible. During the winter program, data were obtained only from 0950 on February 12 to noon on February 14. This record although for the most part continuous, was interrupted during several periods of radio contact when the suppressor on the generator proved to be inadequate for the prevention of spark gap static. Precipitation and icing effects were not found to interfere with the effectiveness of the transparency of the pyrheliometer glass bulb. It is not clear what effect low variable temperatures may have had on the accuracy of the record.[6]

The radiation record, although short, was taken over a period when conditions varied from 5/10ths cloud cover to complete overcast. The 12th of February had a minimum temperature of 11.1°F., visibility 30 miles, wind from the north and east and clear skies. The 13th of February had easterly winds, a minimum temperature during the day of 13°F. and light snowfall with sun dimly visible most of the day. The 14th was with continuing low visibility, heavy snow, variable winds from the west and with minimum temperatures of 18.2° and 20.8°F., in the hours between 0700 and 1300. Eight and one-half inches of new snow had fallen since 0600 the previous day. This approximated blizzard conditions, but without high winds. The highest wind velocity during the period of record was 18 miles per hour (gusts) at 0700 on the 13th, although before the pyrheliometer was turned on winds up to 50 miles an hour had been experienced earlier in the morning.

[6]The sensitivity of the Eppley type of instrument to variations in ambient temperatures has been found, by a National Bureau of Standards test, to lie below 0.5 and .11% per degree C. It is probable that these errors are relatively small at the temperatures encountered during this short period of record. The ambient temperature effect and related considerations important to eventual analysis are discussed in the following publication: National Bureau of Standards Report No. IV, 5/Tp: 45/z-17/46, 10 May, 1946. For requisites in precision measurements also refer to: MacDonald, T.H., "Measurement of Solar Radiation in the Arctic", Proc. Alaskan Science Conf. 1950, Bull. of the Nat. Research Council, No. 122, April 1951, pp. 75-76.

The timing of the record in February, owing to circumstances beyond the control of Camp 10 personnel, was such that the records require special interpretation. This was due to the use of the local generator mentioned above. For example, on the February 12 sheet, interpretation is complicated by the fact that an hour of record is missing at the 1200 time of radio schedules when the generator had to be shut off so as to reduce the interference with radio communication. Also at this time, the generator fuel tank was refilled. With proper adjustment made for this hour of broken record, it is possible to interpret the timing on the sheets and to derive values for comparison with the summer records.

For future records with such an instrument, it is important that the following suggestions and methods be followed to assure accuracy of the data obtained and to reduce them to results which can be easily plotted. Some of these suggestions are made by I. F. Hand, official in charge of the U. S. Weather Bureau Solar Radiation Field Testing Station in Boston, Mass.[7]

(1) Use a constant output, voltage-regulated generator for power.

(2) Make certain the record sheets in the recorder are timed frequently.

(3) Make a notation of every period where the record may be lost due to interruptions, especially at the beginning and end of the missing period. Especially record and time all power failures to indicate this source of serious departure from true timing.

(4) Note and record presence of any haze in the atmosphere and any shading by mountains, buildings or other obstructions.

(5) Keep in mind the possibility that in using a pyrheliometer on snow-covered terrain there may be multiple reflections from the snow cover to constituents in the atmosphere and back to the bulb.[8]

(6) For official information reference on the use of this type of equipment and on the proper integration of data, see Chapter A16, Solar Radiation, Addendum to Circular N, 6th Edition, U. S. Weather Bureau, Washington D. C.

A few notes on the techniques of reducing data are also given here.

(1) Convert the 120th meridian time to solar time, or better than this maintain the record sheet on solar time making sure that one of the time lines coincides with an even hour. This saves drawing in hour lines between the orthodox lines printed on the record sheet.

[7] Personal communication.

[8] On a recent antarctic expedition this occurred and resulted in added reflection with values quite unlike any obtained elsewhere from similar causes. The factors involved in this case and the net effects of an increase in insolation due to cloud reflection onto snow covered terrain are discussed in: Peterson, H. C., "Results of the Solar Radiation Project of the Ronne Antarctic Expedition", Tech. Report No. 3, Office of Naval Research, October 1, 1948, p. 15.

(2) After counting the areas between the trace and the zero line, and between hour lines, tabulate these values in the proper hour intervals.

(3) Multiply these values by the appropriate factor to reduce to langleys.[9] These values may be totalled to obtain daily values and therefore can actually be resolved by simple arithmetic.

For future reference the following specifications are noted in this report. They provide the calibration of the equipment used at Camp 10 as listed by H. Carle, U. S. Weather Bureau electronics technician who visited the ice field station in August 1951 for purposes of determining the full-scale values.

Solar Radiation Recorder and Integrator Calibration Data

Station: Camp 10, Juneau Ice Field Research Project    Date: 8/11/51    Compensator Setting: None

Brown Electronic Recorder, Serial No.: 335,304    Pyrheliometer Serial No.: Eppley 2064

Pyrheliometer Constant: 2.17 millivolts[10] Calibrated by H. Carle, U. S. Weather Bureau

| Millivolt Input to Recorder | Full-Scale Reading |
|---|---|
| 5.10 | 100.0 |
| 4.59 | 90.0 |
| 4.08 | 79.9 |
| 3.57 | 69.9 |
| 3.06 | 60.2 |
| 2.55 | 50.0 |
| 2.04 | 40.0 |
| 1.53 | 29.9 |
| 1.02 | 19.9 |
| 0.51 | 10.0 |

[9]Gram calories per square centimeter per hour. From the calibration data given, the multiplication factor for the Camp 10 records is .235, to be applied to recorded hourly totals.

[10]Per gram calorie per square centimeter per minute.

Of interest is a comparison of the records at this ice field station with those of two other Alaskan stations which have operating pyrheliometers at the present time. Records from the Bethel Station are of particular interest since this site lies only a little more than two degrees of latitude north of the Juneau Ice Field Station.

| Date | Bethel, Alaska Lat. 60° 47' N. | Fairbanks, Alaska Lat. 64° 40' N. | Camp 10[11] Juneau Sector Lat. 58° 39' N. |
|---|---|---|---|
| | | **MAXIMUM VALUES FOR HOUR ENDING NOON** | |
| 2/12/51 | 32 ly. | 30 ly. | (34 ly.) |
| 8/16/50 | 63 ly. | 59 ly. | 74 ly. |
| | | **MAXIMUM DAILY TOTALS** | |
| 2/12/51 | 149 ly. | 157 ly. | (185 ly.) |
| 8/16/50 | 569 ly. | 494 ly. | 647 ly. |

At the present time, a specially constructed totalizing radiometer is being given a preliminary field test in anticipation of its eventual improvement for use on the surface of the Taku Glacier in determining long wave (outgoing) radiation. The thermal balance between incoming and outgoing radiation during all hours of the day and night is of vital importance in any evaluation of the heat budget at a glacier surface and of the factors relating to ablation. This record, like that from the pyrheliometer, will be registered in gram calories per square centimeter per hour. This should allow a more quantitative approach to the problem of surface regimen on the ice field.

[11] The August 16 values are for a cloudless day. The February 12 trace was obtained on a partially clear day with 5 hours of sunshine representing 55% of the total possible, but with a 10/10 overcast in the evening. The February 12 records listed in parenthesis have been interpolated by comparison with the nearest (latitudinal) stations and by approximation by formula.

4. Notes and Recommendations for Future Radiation Measurements in the Ice Field Meteorological Network

For possible future actinometric measurements especially at the Camp 10 and 10B sites, the following suggestions are given. These are based on recommendations of the Radiation Commission of the International Meteorological Association in regard to such special stations and to the general study of actinometry.

(a) Continuous (or at least full day period) recording of total radiation of sun and sky on a horizontal surface. It is desirable, at least, to have three observations a day on clear days. These should be made either at the main synoptic hours or at times corresponding to definite solar heights. One of these should coincide, if possible, with the passage of the sun across the noon meridian.

(b) Regular records of direct solar radiation, in terms of total radiation and for selected parts of the spectrum.

(c) Long wave or effective outgoing radiation measurements ("nocturnal radiation", especially from snow surface). At least one such observation should be taken each night during clear skies, and the first observation in any event should be made soon after the end of twilight.

(d) Duration of sunshine records (see next section) should be made in any case and if possible also with measurements of the total radiation.

The International Commission also recommends that the following instruments may best be used whichever are available to the station in question.[12]

Recommended for direct solar radiation measurements:

Compensation pyrheliometer (Ångström type)
Silver-disk pyrheliometer (Smithsonian type)
Bimetallic actinometer (Michelson type)
Actinometer with Moll-thermophile (Moll-Gorczynski type and Linke-Feussner type)

Recommended for measurement of total radiation of sun and sky on a horizontal surface:

Solarimeter, Moll-Gorczynski with recorder
Pyrheliometer, Eppley with recorder

Recommended for eventual measurements of effective long wave (outgoing) radiation:

Compensation pyrgeometer (Ångström type)[13]

[12] Camp 10 instruments available to this winter project were a 50-junction Eppley pyrheliometer with a Brown recorder and a Campbell-Stokes meter.

[13] See page 12 regarding totalizing radiometer.

5. Duration of Sunshine Record

A Campbell-Stokes duration of sunshine recorder was employed at Camp 10 during the full period from January 26 to February 26, 1951. Eleven days of almost completely clear weather occurred during this period. These were the 27th, 28th, and 29th of January and the 4th, 5th, 9th, 10th, 11th, 12th, 20th and the morning of the 26th of February. Most of the remaining days had overcast sky or light to heavy snowfall. Fig. 3 (a & b) and Appendix A give details of the number of hours of continuous and effective sunshine at the latitude of this station (Lat. 58°39'N.). In Appendix C the record at the U. S. Weather Bureau Station at the Juneau Airport (Lat. 58°22'N.) is presented for this winter period, for January and February, 1949 and 1950, and for August, 1949, 1950 and 1951. Related meteorological information is also included in Appendices A and B. It was to be expected, as indicated here, that some of the coldest days were associated with the clearest skies. Duration of sunshine data have also been obtained at the Camp 10 site during the summer periods of 1949, 1950 and 1951 and will be continued on future operations. These data are included in other reports of this project. From such records, it is expected that those aspects of the thermal regime which relate to insolation will be better clarified.

From the short term records given in this report, the following facts are indicated. During the period of observation in January and February, there appears to have been more than twice as much "possible" sunshine recorded at the Juneau Airport Station as at the upper Taku Glacier Camp 10 site. In the summer period (August), used here for comparison, a different situation occurred; there was nearly the same amount of sunshine recorded at each site. (See Fig.3). These facts are further illustrated by the following table, which shows comparative totals of recorded sunshine at each site.

TOTAL RECORDED SUNSHINE

| Date | Juneau Airport (24 ft. Elev.) | Camp 10, Taku Glacier (3875 ft. Elev.) |
|---|---|---|
| Aug. 1949 | 214 hours 29 minutes | 191 hours 6 minutes |
| Jan. 27 to Feb. 27, 1951 | 127 hours 49 minutes | 51 hours 5 minutes |

Corollary to the foregoing comments, we must consider the fact that the Juneau records represent corrected values based on exact times of sunrise whereas the Camp 10 records are based only on the amount of direct sunlight shown by the Campbell-Stokes recorder. In other words, the Airport Station records have been adjusted to include the number of minutes that the sun would have shone from a flat horizon prior to the time that its rays actually affected the sensitive plate of the sunshine recorder. For proper comparison, however, the emphasis should be placed on differences in the effective sunshine at each site. This means that elevation and orographic differences as they influence the amount of sunshine received at various seasons of the year must be considered. Specifically, the difference of nearly 4000 feet elevation, the different degrees of obstruction imposed by surrounding topography, and the fact that Camp 10 is on a ridge top and that the Juneau Airport is in the bottom of a valley are all pertinent. The Camp 10 station is also slightly farther north.

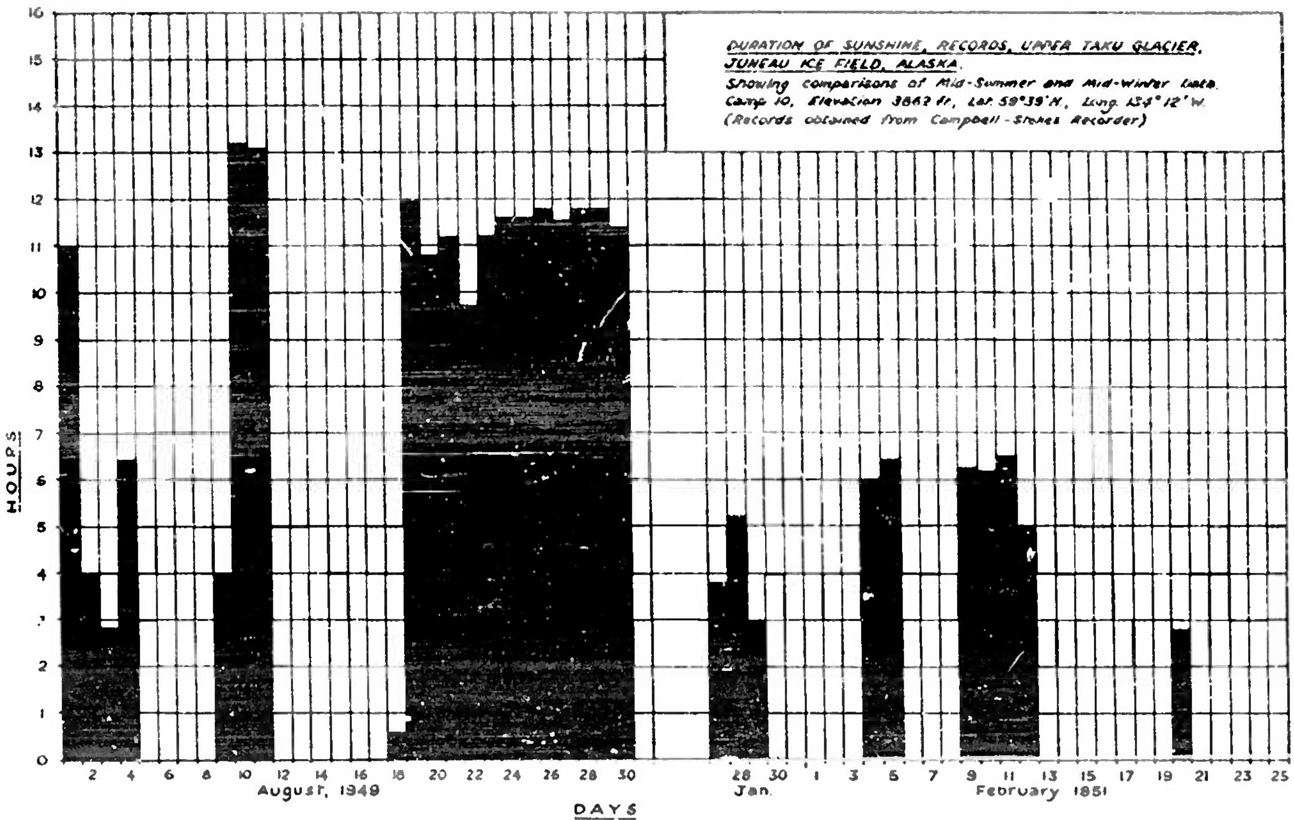



FIG. 3A. Duration of sunshine records, upper Taku Glacier, Juneau Ice Field, Alaska.

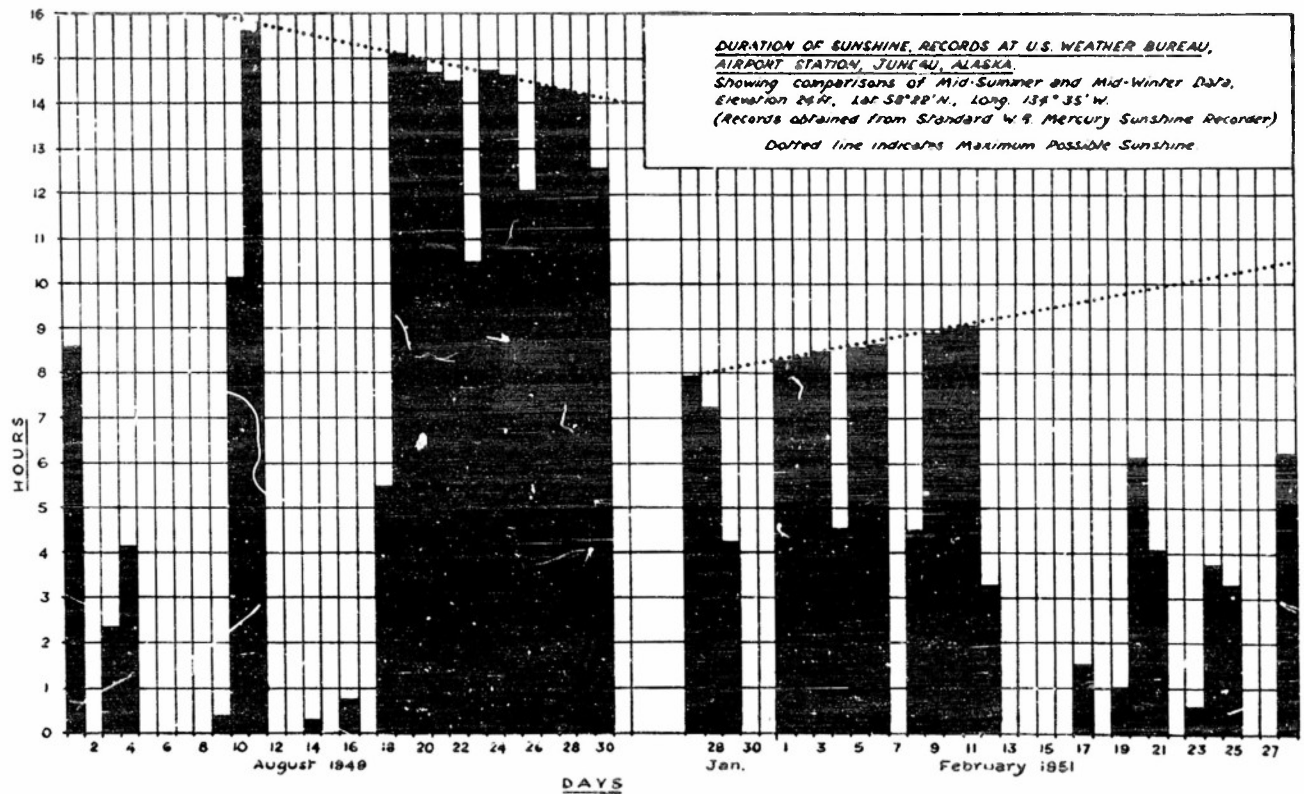



FIG. 3B. Duration of sunshine records at U. S. Weather Bureau, Airport Station, Juneau, Alaska.

Special aspects of these considerations are discussed in the 1950 and 1951 summer reports. It is briefly noted here, however, that Camp 10 lies in a broad region of fairly accordant summit levels and is more or less unobscured during daylight hours. Therefore, its record is essentially one from a flat horizon. Since the Juneau records have already been reduced to values for a flat horizon, the factors causing discrepancies between the two stations tend to cancel each other. The degree of correspondence has not yet been fully evaluated; however, when this is done it should be possible to establish a set of correlation soefficients for different months of the year. In this way, the Juneau records may be of use in determining the approximate amount of corresponding duration of effective sunshine at the intermediate elevation on the Taku Glacier during periods when there is no record from Camp 10.

## 6. The Evaluation of Sunshine Records

In order that comparable and consistent results from Campbell-Stokes duration of sunshine records can be obtained for future comparison at the main research station a few notes are presented here. These should also aid in the proper evaluation of such records. The first two suggestions are taken from the list of recommendations of the Sub-commission on Actinometry of the Commission on Instruments and Methods of Observation of the World Meteorological Organization.[14] The other recommendations are from personal advice of Dr. W. Morikofer, Director of the Physical Meteorological Observatory of Davos, Switzerland.

(a) With the Campbell-Stokes instrument it is advisable that recording cards of the same color and thickness be used at each station and on each occasion. The standard cards of a medium blue color, and of a thickness of 0.4 mm. are recommended. Special attention is drawn to the fact that errors will be introduced if the time graduation on the cards is not proper.

(b) It is strongly recommended that the calculation of the percentage of possible hours of sunshine, or the relative duration of sunshine, be referred to a maximum duration of sunshine given by study of the records of the same instrument for the locality and time of question. These maxima should also be published. (See Figure 3b)

(c) Even the slightest trace of a burn on the card must be evaluated.

(d) If the card is burned through, then it is recommended that only those parts be evaluated. In this case, the exterior edge of each burn does not count. Consequently, for a deep burn, every indication of a narrowing of the track width must be deducted at least within 1/10 of an hour.

(e) Short tracks, like circles which are not burned through, are to be evaluated even if only one minute. They must be added for the interval of evaluation (hour or day) and transformed into tenths of hours. If there is only one such burn within the interval of evaluation, it must be counted as 1/10 of an hour.

[14] Prepared jointly by this Committee and the Radiation Commission of the International Meteorological Association at the Brussels Congress of the International Union of Geodesy and Geophysics, August 1951.

(f) For climatological purposes, it is more important to know the duration of sunshine of a day or month than it is the exact value of each hour. If the addition of the duration of sunshine of each hour and the evaluation of the daily sum is differing, then the exact daily sum is decisive. Care must be taken that the hourly values are adopted so that the sum corresponds with the exact daily total and so that each hour in which the sun has shown is noted.

## 7. Observed Short Term Changes at the Snow Surface

A record of snow accumulation was maintained at both camps. The measurements, of course, could not be expected to represent exact increment of new snow at all times. For example, the effect of wind drift, or supplementary deposition of previously fallen snow blown in from other parts of the ice field, increased the value of net accumulation in some sectors. On the other hand, the erosion and wind scour of the older snow surface, even during some of the periods of actual snowfall, would deflate snow from the recording site and reduce the net value of the immediate record. Usually, additional drift deposition would occur to supplement actual snowfall. At Camp 10B (which, being on a broad flat stretch of the glacier, was not on such an exposed ridge as Camp 10), wind scour during periods of storm was relatively less. The greatest corrasion occurred on clear days when the velocity of surface winds exceeded 20 miles an hour. This, of course, created drifting and supplementary accumulation at lower levels and especially on the edges of the ice field. The snow blasted from the highland area would be carried hundreds of feet into the air and drained outward by katabatic winds.

The heaviest accumulation of snowfall occurred during the last 14 days the project was in the field. In seven of these days, a total of 72 inches of new snow was deposited at Camp 10B. There was much less net accumulation at Camp 10 because of the exposed ridge position and the contemporaneous removal by wind of nearly all snow which fell. On January 26, approximately 12 feet of compacted snow covered the Taku Glacier surface at the Camp 10B site. The top one and one-half feet of this was dry, fresh powder overlying an earlier wind crust. Skis of the supporting aircraft sunk in 8 inches on the initial landing on that date. Clear weather, with occasional high winds, continued until February 13th when the above mentioned prolonged blizzard commenced. During the period of clear skies on February 2nd, high winds considerably scoured and eroded the glacier surface and re-deposited much drift snow in the vicinity of the occupied camps. On that day, it was necessary to shovel out several feet of drifted powder each time the door of the research station (Camp 10) was opened. On this occasion, the winds packed the snow surface on the glacier and drifted powder snow into crevasses, covering them from view.

The hardening effect of the wind-packing was much more noticeable on the 30° slope west of Camp 10 than on the glacier flat in the vicinity of Camp 10B. On several occasions during the February period this surface became so hard that Bramani-soled boots and even the tips of ski poles would leave only a slight impression. This was particularly true in the below-zero temperatures experienced during the first half of February. By the 10th and 11th of February the Camp 10 slope had approached a "consistency of concrete". A few days later, it was covered deeply with many feet of soft powder snow. This period

was one of great contrasts which materially affected logistic operations in the field. On one occasion, as a result of the considerable depth of soft new snow it was impossible to take advantage of a U. S. Air Force 10th Rescue Squadron ski-wheel C-47 which had flown down from Anchorage in anticipated support. In future operations, however, it is probable that such a heavy aircraft would have little difficulty in landing on the ice field, as long as it came in at a time when a dense wind-packed surface had developed over a period of a week or more. Under most other winter conditions, landings would be difficult.

Details of the nature of changes and in conditions of accumulation on the February surface at these sites are given in the following Table 1. It is of interest that although 87 inches of new snow accumulated near pit B at Camp 10B in February,. by the month's end at least 30 per cent of the effective height of the column of gross accumulation (Figure 7) had been reduced by processes of settling and by deflation. It is estimated that about one-fifth of this total reduction may be attributed to aeolian processes.

TABLE I - Nature of Surface Conditions and Accumulation

at 3,600 - 3,900 feet, Taku Glacier

| Date | Conditions | | Measured Fresh Snow (inches) 10 | 10B |
|---|---|---|---|---|
| 2/1 | Mostly overcast | | - Trace - | |
| 2/2[15] | Partly cloudy | | Drift: up to 24 | |
| 2/3-6 | Clear, to partly clear | | Drift: 3 at 10B | |
| 2/7 | Storm | | 1.1 | 1.0 |
| 2/8 | Storm | | 4.0 | 3.0 |
| 2/9 | Clear | | - Trace - | |
| 2/10 | Clear | | | |
| 2/11 | Partly clear | | | |
| 2/12 | Overcast | | | |
| 2/13 | Storm | | ( 5.0 for both camps | |
| 2/14 | Storm | | (10.0 | 20.5 |
| 2/15[15] | Storm | 72 | ( 9.0 | 10.0 |
| 2/16[15] | Storm | inches - | ( 5.5 | 15.0 |
| 2/17 | Storm | (10B) | ( 1.0 | 7.0 |
| 2/18[15] | Storm | | (13.0 for both camps | |
| 2/19 | Storm | | ( 1.5 for both camps (Drift: 5 at 10B | |
| 2/20 | Partly cloudy | | - Trace - | |
| 2/21 | Mostly overcast | | 0.5 for both camps | |
| 2/22 | Storm | | 3.5 for both camps | |
| 2/23 | Storm | | 2 for both camps | |
| 2/24 | Storm | | 0.5 for both camps | |
| 2/25 | Clearing | | - Trace - | |
| 2/26 | Clear | | | |
| 2/27-28 | Storm | | (Estimate - 5) | |

Approximate 10B total - 87 inches

[15] Days with heaviest wind drifting of snow and/or development of rime. From the above record it may be seen that in mid-winter clear skies, cold weather, maximum wind scour, and snow surface corrasion seem all to be associated with northerly winds. Severe blizzards and heavy accumulation which are sometimes, but not always, accompanied by moderately high winds, are brought in by regional air flow from the southeast. Rime ice is also characteristic of some of these southeasterly storms.

TABLE I (continued)

| Wind Direction | Average Velocity (mph) | Remarks |
|---|---|---|
| NE | 5 | Little surface effect |
| N (high) | 21 | Much scour and corrasion |
| N | 9 | Much scour and corrasion |
| W | 6 | Little surface effect |
| Variable W-E | Slight | Little surface effect |
| E | Slight | Little surface effect |
| N | Slight | Little surface effect |
| NE | Generally calm | Little surface effect |
| N, then slight W | | Little surface effect |
| N | 6.5 | New accumulation |
| NW, then SE | 2-3 | New accumulation |
| ESE | 22 | New accumulation |
| S (10B) | 16.5 | |
| SE | 20-22 | New accumulation |
| NE, slight W | 1.5 | Little surface effect |
| E and SE | 23 (10)<br>12 (10B) | Scour and corrasion |
| E down-glacier | 2.5 (10)<br>1.5 (10B) | |
| E | 1.5 | |
| SE | 14 (10)<br>6 (10B) | |
| SE | 21 | |
| SE | 13 | |
| NE | 20 | |
| N | 20 | |
| Shift in p.m. | Calm | |

6. Surface Temperature Measurements in the Katabatic Air Layer on the Taku Glacier at Camp 10B.

Nine resistance thermometers were positioned at selected levels up to 30 feet above the upper Taku Glacier surface in order to obtain measurements of diurnal temperature gradients in the katabatic air layer. For this purpose, the thermistors in Cable No. 151 (Appendix G) were strung on the antenna mast in such a way as to preclude any influence from contact with the metal of the mast (Fig. 5).

The temperature profile records may have been somewhat levelled by the presence of a rubber protective covering on each thermistor. Due to radiation influences which could not be eliminated, the temperature measurements taken at mid-day may also be slightly higher than true values. With the equipment available, it was not possible to provide artificial aspiration around the individual units. It is probable, however, that the steady down-glacier drainage of air, seldom with a velocity of less than four miles per hour, supplied this requisite circulation.

The levels of ambient temperature record above the snow surface are given in Figure 7. By reference to Table V, Section B, 3 (a), variations in snow accumulation may also be checked. Changes in the reference levels of the snow surface are important to consider in the eventual interpretations since they created periodic differences in the height of individual thermistor units above the surface and also brought about the burial of the lower thermistors (Nos. 1189 and 1190). The position of these bottom units may give additional useful information concerning changes in surface snow temperatures to supplement those taken by other means as shown in Figures 5 and 6. Figure 7 shows diagrammatically the relationship of short term variations in snow depth to the height of the individual thermistor units.

Results of these temperature readings are tabulated in Appendix G. An analysis of the data is not included in this report; however, a graphical presentation of several days of record is given in Figure 8. Plotted values for some hours may be slightly higher than true values as a result of the previously mentioned radiation heating of the thermistor cable. Such a situation is indicated by the record for 1300 on February 8 (Fig. 8). A mercury thermometer in the meteorological shelter recorded a below-freezing temperature at the same hour at the three-foot level. The meaning of above-freezing temperatures, especially on the bottom thermistor buried in fresh snow two feet beneath the surface (Fig. 7), is not fully clear. Since the snow could not have been above the freezing point, this anomolous value may be attributed to one of the following factors: (1) radiation penetration of the snow surface, causing the rubber-capped thermistor to become slightly warmed; (2) a lowered resistance of the thermistor element due to abnormal heating of the wire in consequence of the battery key being held down too long; (3) an unexpected shift in the calibrated temperature-resistance relationship within the thermistor as a result of external causes; (4) observer error. The latter two possibilities are probably not the effecting ones, since the upper thermistor values at this hour were likewise correspondingly higher than at any of the previous hours of record.

Several preliminary observations may be made from the plotting in Figure 8. Provisionally, it would appear that during the day, nearly the same or even slightly colder temperatures existed at the 30-foot height than at the surface of the snow pack. (See curves for 1600 on February 13 and 14). At night, the more general rule was an inversion with somewhat higher temperatures at the top of the antenna mast than at the snow surface. (See curve for 2200 on February 12).[16] There are also indications that during the morning and evening twilight hours, a temperature equilibrium was the rule with nearly the same values being plotted at all levels up to 30 feet. This apparent pattern may not be significant since all of the records must be plotted fully before an acceptable interpretation can be made. In the final analysis, of course, consideration must be given to every controlling factor. It is hoped that eventually precision temperature measurements may be obtained for comparison at different seasons and to greater heights above the snow pack. These should be made in conjunction with other meteorological information gathered at the corresponding levels.

The ultimate effect on temperatures at Camp 10B of the katabatic cold air flow from the higher regions of the ice field cannot yet be quantitatively determined. The measurements given here, however, even though subject to possible errors, do provide a key to that analysis. Further temperature profiles at this site and additional records of wind direction, velocity and humidity at the same heights in the summer of 1951 have provided some useful supplementary information. These data are being incorporated in a subsequent report.

## 9. Regional Climatology during the Period of Observation

Pertinent weather records from most of the permanent and semi-permanent stations shown in Figure 2 are available in appendices A through F. These and data from other coastal stations[17] may be supplemented by the statistics listed in U. S. Weather Bureau "Climatological Data", Vol. 37, Nos. 1-3 (Jan.-March), Alaska, 1951. Annual records are also available at each station. In the future a year around record may be obtained at Camp 10 for a more useful comparison.

[16] A similar situation seemed to prevail in winter at the Central Station of the 1950-51 expedition of Expeditiones Polaires Françaises in Greenland. This station was situated at 10,000 feet elevation near the center of the Greenland Ice Cap. Records were made at levels from 26 to 141 cm. above the ice surface (roughly one to five feet).

[17] Within 200 miles of Juneau are the following permanent stations in Southeastern Alaska; Angoon; Annette; Baranof; Beaver Falls; Cape Decision; Cape Spencer; Craig; Eldred Rock; Five Finger Light; Guard Island; Gull Cove; Gustavus (CAA station); Haines (CAA); Ketchikan; Lincoln Rock; Little Port Walter; Mile 28 Haines Highway; Petersburg (CAA); Point Retreat; Port Alexander; Sitka (CAA); Skagway; Tenakee; Tree Point; and Wrangell.

February was drier and cooler than normal for the region. According to the Juneau records, March of 1951 was the coldest March since cooperative weather records were begun there in 1881. A mean temperature of 27.6°F. in 1918 came closest to the 27.2°F. mean recorded in March 1951. In Juneau city the lowest temperatures and the mean for January, February and March, 1951 are noted here (See also Appendix D).

| | | |
|---|---|---|
| January | Mean | 26.4°F. |
| | Normal | 27.8 |
| | Minimum | 7.0 |
| February | Mean | 25.6 |
| | Normal | 30.1 |
| | Minimum | 10.0 |
| March | Mean | 27.2 (26° at Airport) |
| | Normal | 33.8 |
| | Minimum | -1.0 |

It is apparent from this that February was the coldest month, although the 5th of March was the only day when the temperature dropped below zero (F.). In January and February, there was more sunshine in Juneau than is normally expected. The wettest and warmest period was from the 13th to the 21st of February, during which much of the accumulated snow in and around Juneau melted and caused some difficulty in ski-aircraft operations. Also, during this period, the heaviest total snow fall occurred at Camp 10. A total precipitation of 2.30 inches fell at the Juneau Airport from February 1 to the 26th. This is less than 55 per cent of the amount which fell at Camp 10. Of interest in the Juneau (airport and city combined) records is the following:

Juneau statistics for the February period since 1881[18]

| | On Record | | Feb.'51 |
|---|---|---|---|
| Highest Temp. | 46 | (1944) | 36 |
| Lowest Temp. | -12 | (1949) | -8 |
| Mean Max. Temp. | 31.1 | (Av.) | 28.3 (Av.) |
| Mean Min. Temp. | 19.5 | (Av.) | 14.8 |
| Mean Monthly Temp. | 27.5 | (Normal) | 21.6 |
| Total Precipitation (in.) | 4.2 | (Normal) | 2.31 |
| Max. Wind (m.p.h.) | 36 SE | (1946) | 31 SE |
| Total Snowfall (in.) | 18.1 | (Av.) | 20 |
| Average Cloudiness (per cent) | 77 | (Av.) | 57 |
| Possible sunshine (per cent) | 34 | (Av.) | 41 |

The records from the Big Bull Mine, near Tulsequah, B.C. on the east side of the ice field, are also of interest. (See section A1 and Appendix F of this report.) The temperatures at Tulsequah indicate a more continental climate with all mean values running 2 to 4° colder than at Juneau or Annex Creek during the month of February. The mean temperatures at Camp 10 average 5° colder than those at Tulsequah and 10° colder than Juneau. The precipitation at Big Bull Mine was about the same as that recorded at the Juneau Airport with the exception of the month of February. During that month the precipitation at Tulsequah was only 57 per cent of that at Juneau city and 47 per cent of that recorded at Annex Creek in Taku Inlet.

[18] All temperatures in degrees Fahrenheit.

It should be pointed out that for the whole area of Southeastern Alaska, the upper air circulation pattern for February was based on a ridge of high pressure over all of eastern Alaska (continental sector) and a low pressure area in the western Bering Sea. This produced a westerly flow of air over eastern Alaska with average to below average wind velocities. Precipitation, as in January, was below normal throughout Southeastern Alaska.

During the first 10 days of February there was little precipitation anywhere in the territory. On the 9th and 10th of February, a pronounced low in the Bering Sea resulted in a southeasterly flow of air in that area, a westerly flow over central Alaska, and consequently a northerly flow over the Southeastern Alaska "Panhandle". Within several days, this brought in the southeastern storms. From the 13th to the end of February, stormy to "blizzard" conditions prevailed in most other areas of Alaska. Apparently the storms in the "Panhandle" were not particularly abnormal. The U. S. Weather Bureau's climatological survey for the month states "the Pacific Coast and Southeastern districts continued dry with the exception of the extreme southern "Panhandle" which received about normal precipitation."

B. GLACIOLOGICAL

The glaciological observations were entirely confined to the vicinities of Camps 10 and 10B. They consisted essentially of the use of standard snow profile techniques for the determination of characteristic density, hardness, stratigraphy, and so forth, as well as special characteristics such as the salinity of new snow samples and compaction and settling rates. As a continuation of the 1950 summer research program, the thermal regimen in the upper 170 feet of the glacier, including its firn and winter snow deck, was also investigated. Records of the surface and englacial movement at Camp 10B were obtained. Each of these programs is preliminarily discussed in the following pages. A complete presentation of the records involved is included in this report, either in the text or in the appendix.

Since most of these studies were carried out in the upper zone of new snow, none of which was older than five months (above the firn surface of September 28, 1950; see Figure 5), the terminology "new snow" and "old snow" is used in this report. "New snow" is used to refer to that surface layer which was, at the time of study, only a few days old and in which the original form of the crystals could still be recognized. "Old snow" is considered to be that settled and denser material which fell a month to five months before and whose transformation had advanced so that the original form of its crystals could not be recognized. This arbitrary general classification for purposes of the present report should, in future work in this area, be amplified by the refined nomenclature recommended by the International Committee on Snow Classification.[19]

[19]Appendix 2 of "Draft of an International Snow Classification", Memo of the International Association of Scientific Hydrology, Congress of the I.U.G.G., Brussels, 1951.

The writer has recently given thought to the problem of terminology in the firn or névé area. The following notes taken from a discussion of this aspect in another publication, are reviewed here.[20] They are pertinent to these investigations and may be of value in future studies of this project. These comments deal with the general nomenclature for a snow cover <u>after</u> its "old snow" (as noted above) has begun to be metamorphosed into definitely recognizable firn and <u>before</u> it has reached the stage of densification which we know as solid ice.

## 1. Notes on Terminology

The terms névé and firn, when used interchangeably in the same publications in English might cause one to ask whether they should in fact connote a difference in meaning. Actually, their use should not create too much difficulty. The word <u>firn</u> is derived from the German adjective fern which means "of last year" (also "far" or "distant") and thus in most usual application refers to glacier snow from the preceeding year or years.[21] The French word <u>névé</u> by definition means "a mass of hardened snow of glacier origin".[22] In English there is no single descriptive word. One would instead probably use a phrase such as "consolidated, granular snow not yet changed to glacier ice". Therefore, a similar connotation exists in each language.

French and Swiss glaciologists usually consider that névé is a more or less dense and settled, although permeable, aggregate of medium to large individual grains formed and welded together by frequent alternations of melting and freezing on the surface of original snow crystals, and in which one often finds numerous layers of ice. More generally, they use the word to refer to the overall snow cover which exists during the melting period and sometimes from one year to another.[23]

The definition of <u>firn</u> adopted by the Eidgenossische Institut für Schnee-und Lawinenforschung at Davos, Switzerland and included in the latest "Draft on an International Snow Classification" of the International Association of Scientific Hydrology is as follows: "old snow which outlasted one summer at least (transformed into a dense, heavy material as a result of frequent melting and freezing)".

[20] See note by Miller, M. M, concerning "The Terms Névé and Firn", <u>Journal of Glaciology</u>, Vol. 2, No. 12, 1952, pp. 150-151.

[21] DeVries, L., German-English Science Dictionary, McGraw-Hill Book Co., New York, 1946. Also see Cassell's German and English Dictionary, 1951.

[22] Noveau Petite Larousse, Dictionnaire Encyclopédique, 1951

[23] Roch, André. "Precisions sur quelques termes de langue francaise concernant le neige et les avalanches", <u>Die Alpen</u>, Jahrg 20, 1944, pp. 21-23.

Since all of our scientific nomenclature cannot practically be reduced to one language, it should be acceptable to use the French or German or even an appropriate English equivalent, according to the dictates of one's particular native tongue. One should not reasonably expect a French glaciologist to substitute the word firn for the analagous term névé in his own language and of course, vice versa. We English speaking persons actually bear the burden because we are most willing to employ either of the foreign terms than to use a phrase of our own. This is true due to the advantage of brevity and also, of course, since each has become well ensconsed in the mass of glaciological literature which has been written in French and in German.

If any differentiation is warranted, it should certainly not be one which eliminates all synonymity. On the other hand, it might be useful for publications in English more universally to adopt the word névé as a geographic term, e.g. the Taku Glacier névé, meaning the highland area of the Taku Glacier covered with perennial snow and thus lying entirely in the zone of accumulation. The word firn could then be more usually applied in reference to the material itself. In this way, the original meaning of both terms would be left intact, and the confusion introduced by indiscriminate use of them in any one publication would be eliminated. This would also be in accordance with the view taken by some British glaciologists including Mr. Gerald Seligman, who as long ago as 1936 published the following suggestion:

"If we take 'Firn Snow' (I prefer this word to Firn) and use it for snow particles in the befirned condition and 'Névé' to indicate the accumulation area above a glacier, we give the two words distinct meanings and have neater and conciser terms for the two things than exist in either French or German."[24]

Concerning application of these terms to snow cover on high polar glaciers (or even possibly in relatively dense "old snow" during winter months on a temperate glacier such as the Taku), a modified or qualified nomenclature might be advisable. This is brought to mind more and more as differences in physical aspects and in metamorphic processes in temperate and polar glaciers are quantitatively outlined. On the antarctic continental plateau and at the ice cap surface near the center of Greenland, practically no thaw water plays a part in the "firnification". In such cases, for field use at least, a terminology based on density might be of value (or in the laboratory the basis of permeability could be used). An arbitrary line of division for firn could perhaps most simply be placed at specific gravity 0.74, which has been shown experimentally to be the maximum density firn can achieve due only to the process of compaction of spherical grains without presence of melt water.[25]

[24] Seligman, Gerald, "Snow Structure and Ski Fields", Mac Millan and Co., London, 1936, p. 116.

[25] de Quervain, Marcel, "Mitteilungens aus dem Schweizer Eidgenossische Institut für Schnee-und Lawinenforschung", Mechanisch-Kristallographische Untersuchungen, 1946.

Under high polar conditions (or sometimes in winter surface snow cover in temperate areas), greater densities usually occur by following a fairly smooth curve of gradation at depth until the density of clear glacier ice is reached and maintained. This transition undoubtedly involves re-crystallization under compressive stress, perhaps including "plastic" deformation as well as growth of individual grains without infiltration of melt water. In some manner the intra-crystalline spaces become smaller and more cut off from one another, so that both the mass porosity and the permeability are reduced. Where a division line for glacier ice should reasonably lie in this final sequence of the metamorphosis is difficult to suggest. In temperate summer conditions, a density division even at lower values is often difficult because of supplementary diagenetic changes involving the refreezing of percolated melt water. Thus, irregular ice structures are produced which transect layer boundaries in even some of the youngest stratigraphic horizons. This results in a much more irregular increase of firn density at depth. In either case, the true nature and variations in the process, causing subsequent physical changes in the intermediate ("firn-ice"?) stage between densities 0.74 and 0.92, are not yet well enough known to warrant more than general consideration. Here may be a line of genetic difference upon which a refined nomenclature for perennial snow, at least that in polar regions, could be based.

## 2. Periodic Snow Profiles

Along the line of effort during previous summer seasons, records were made of the various components comprising the mid-winter snow profile above the 1950 firn surface at Camp 10B. These data are presented below.

### (a) Density and Hardness Measurements in 1950-51 Winter Snow Pack above 1950 Firn Level

A toothed 400 to 500 cc. hand corer was employed to obtain the density profiles in pit A on the 7th, 10th and 19th of February. (See Figure 4 and Appendix H.) Measurements were taken horizontally on the wall of a test pit at vertical increments of usually 4 inches (with some spacing as little as 1 in. and others up to 6 in.) between each reading. The reference level used was the previous summer's firn surface with the new snow surface as a check level at the time of record. In Table V and Section B2 (c) of this report, the absolute reference level in relation to the February 21 new snow surface and the late September 1950 firn surface is noted. Also, there can be found a comparison of records with compaction data, snow stratigraphy and other characteristics of the mid-winter snow profile at this site. Figure 4 illustrates the nature of increase in density values and corresponding hardness at various depths during the period of observation. These are attributed entirely to normal settling and also to compaction as a result of the weight of additional new snow which fell on this surface in February. An analysis of these factors will be presented in a subsequent report.

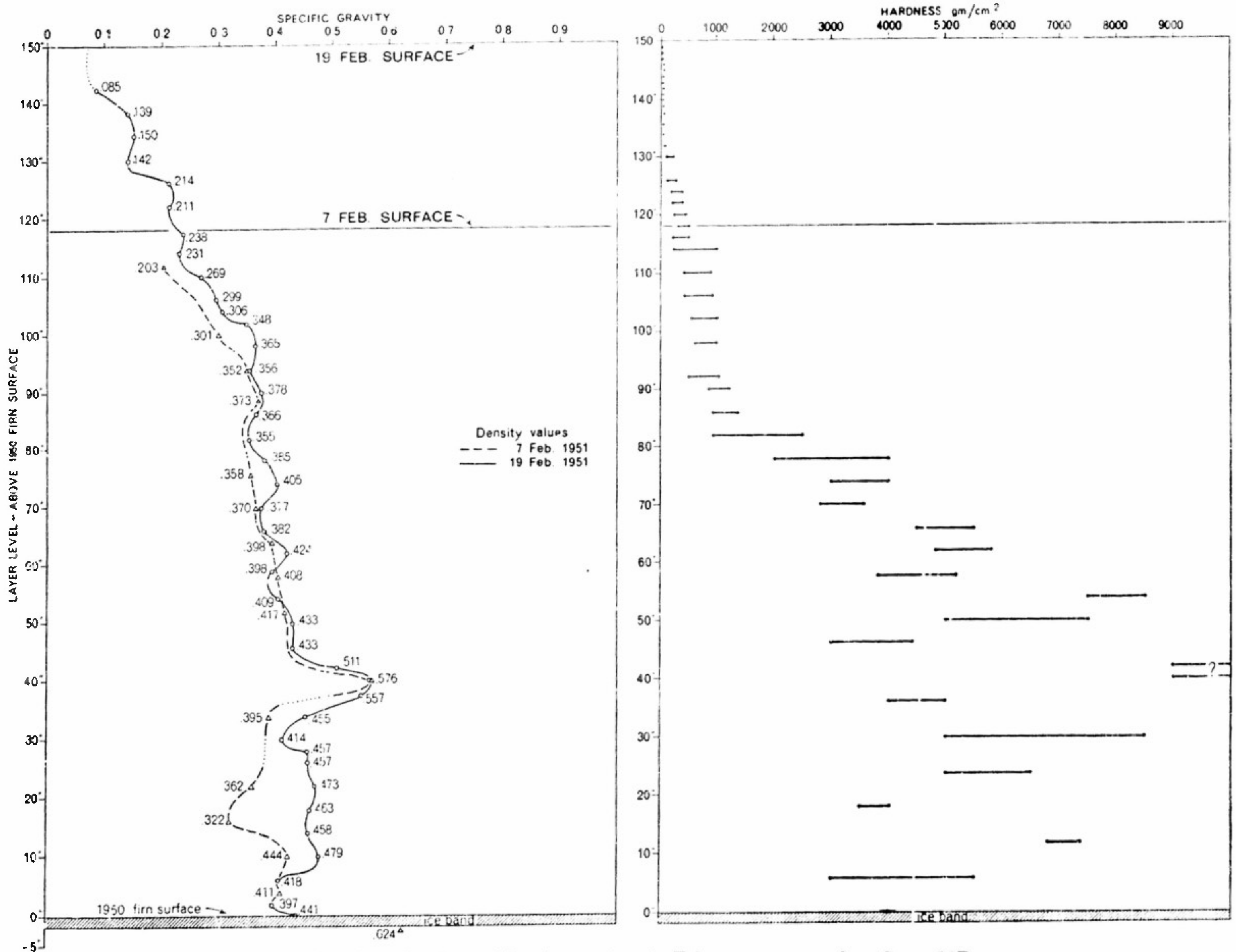



FIG. 4. Graph of density and hardness values in February snow pack at Camp 10B.

On February 21 a profile of snow hardness was also obtained on a freshly exposed portion of the west wall of pit A at Camp 10B. A standard NRC Canadian plate gauge[26] was employed on loan through the kindness of G. J. Klein of the National Research Council of Canada. In addition to the representation in Figure 4, the tabulated results in grams per square centimeter are listed in the tables of Appendix H. These are believed to be representative and statistically significant on the basis of mean values from 10 to 15 samples taken at layer intervals of one to six inches. There is some correspondence between density and hardness values, but an analysis of the factors involved will be delayed until further comparative records are obtained to supplement those presented here.

(b) Settling Rates and Compaction Records

Periodic measurements were taken of the compaction of the horizontal pack of old and new (1950-51) snow above the 1950 late summer firn level in pit A at Camp 10B during the period of February 11th to 25th. Because these observations had to be made in a snow deck which had no previously installed reference levels (such as colored strings stretched between posts prior to the commencement of winter accumulation), it was necessary to initiate a system for recording compaction which would result in the least amount of disturbance to the layers being measured. This was accomplished in the lower snow layers by implanting a series of six horizontally-placed, cylindrical wooden wands of 1/4" diameter. Each wand was carefully pushed into the snow at the desired level from the vertical wall of a pit dug down from the glacier surface. Successive measurements were thereafter taken periodically between the center positions of each wand. The vertical distribution of these wands and their relationship to the snow pack in which the progressive February density measurements were taken is shown in the profile sketch of W.1 to W.6 in Table III. Their position is also tabulated in the following Table IIA. The reference used was the 1950 firn surface as shown.

In addition the settling rates in layers of new snow were observed by noting the change in successive vertical positions of a series of five other wands at a subsidiary site (B). These were installed in such a manner as to extend the readings at greater depths. (See W. A to W. E in Table III column 7.) These measurements were obtained between the 20th and 25th of February in which period 9-1/4" of surface snow were removed by wind corrasion and in which an aggregate of 10.4" of settling also

[26]For a description of this instrument and its comparative merit with other such devices see: de Quervain, M. "Die Festigkeitseigenschaften der Schneedecke und Ihre Messung", Sonderdruck aus der Zeitschrift, Geofisica Pura e Applicata, Milano, Bd. XVIII (Somigliana-Festband), 1950; also refer to: Klein, G.J., Pearce, D.C. and Gold, L.W. "Method of Measuring the Significant Characteristics of a snow-cover", (Tech. Memo. No. 18) National Research Council of Canada, Report No. 2269, Ottawa, 1950.

occurred at the surface (Table IIB). The reference upon which these measurements were based was an eight foot cylindrical wooden dowel firmly pounded in a vertical position from the surface into the denser part of the snow pack at depth. It is considered that the settling of this reference stake in relation to the 1950 firn level was negligible during the five day period of measurement.

Settling and compaction records from each of the above profiles are given in the following tables. Table IIB may be considered to supplement Table IIA as shown by the diagrammatic representation in Table III. It is stressed that both of these sets of short-period data represent mid-winter compaction of new to old snow lying on a nearly horizontal surface and under sub-freezing conditions in which no thaw water was present during the period of observation. (See other sections of this report for information on the stratigraphic character of these profiles and on hardness, density, crystal size and snow types at the various levels influenced by compaction and settling.)

Table II. Compaction Data, Camp 10B, upper Taku Glacier

A. In Pit A, New and old snow (1950-51)

(1) Date of measurement: 11 February 1951
Time of measurement: 1200 P.S.T.
Surface Conditions: New dry fluffy and platy snow in fine layers; crystals of types 1 and 2.[27] Air temperature -15°C. (5°F.) Surface snow temperature, -16°C. (3.2°F.)

| Reference wand | Location relation surface and levels of measured density (density holes of 8 February) | Location above 1950 firn surface (feet and inches) | (mm) | Measured distance between centers of reference wands |
|---|---|---|---|---|
| surface | ------ | 10'3" | 3124 | 7" |
| 1. | 7" below snow surface & 5-1/8" above center density hole No. 1 | 9'8" | 2947 | 5-1/8" |
| 2. | Base d.h. No. 1 | 9'2-7/8" | 2819 | 1'11-6/7" |
| 3. | Base d.h. No. 7 | 7'3-1/8" | 2210 | 1'11-6/8" |
| 4. | Base d.h. No. 13 | 5'3-3/8" | 1610 | 2'7-3/8" |
| 5. | Base d.h. No. 20 | 2'8" | 813 | 2'8" |
| 6. | Base d.h. No. 29 | 0 | 0 | |

[27] Code of precipitation forms, International Snow Classification, 1951

A. (2)

Date of Measurement: 21 February 1951

Time of Measurement: 1100 P.S.T.

Surface Conditions: Approximately three (3) feet of new snow, 2-5 days old. (See appendixed meteorological record and Fig.5 for changes in surface conditions and for an approximation of the net results of accumulation and wind corrasion since 11 February.)

| Reference wand | Location relation surface and levels of measured density (density holes of 8 February) | Location above 1950 firn surface (feet and inches) | (mm) | Measured distance between centers of reference wands | Compaction since 11 Feb. |
|---|---|---|---|---|---|
| surface | ---------- | 12'6-1/8" | 3810 | | |
| 1. | 3'6" below surface of this date which indicates upwards of 2'11" of net surface accumulation since previous reading on 11 Feb. | 9'-1/8" | 2743 | 2'-5/16" | 2-13/16" |
| 2. | Base of d.h. No. 1 | 8'9-13/16" | 2692 | 1'9-7/16" | 2-5/16" |
| 3. | Base of d.h. No. 7 | 7'-3/8" | 2143 | 1'10-1/2" | 1-1/4" |
| 4. | Base of d.h. No. 13 | 5'1-7/8" | 1575 | 2'6-1/4" | 1-1/8" |
| 5. | Base of d.h. No. 20 | 2'7-5/8" | 813 | 2'7-5/8" | 3/8" |
| 6. | Base of d.h. No. 29 | 0 | 0 | | |
| | | | | Total compaction between wands 1 & 6 (10 days) | 7-7/8" |

Supplementary data - 21 February 1951

| | |
|---|---|
| Distance between wand 1 and base of d.h. 1 (Table III): | 3-1/8" |
| Distance between bottoms of d.h. 1 and d.h. 7: | 1'8-11/16" |
| Distance between bottoms of d.h. 7 and d.h. 13: | 1'10-9/16" |
| Distance between bottoms of d.h. 13 and d.h. 20: | 2'6-3/8" |
| Distance between bottoms of d.h. 20 and d.h. 29: | 2'7-3/8" |
| Distance between bottoms of d.h. 29 and d.h. 30: | 0'4" |

A. (3)

| | |
|---|---|
| Date of Measurement: | 25 February 1951 |
| Time of Measurement: | 2000 P.S.T. |
| Surface Conditions: | The surface of the previous snow accumulation (prior to 21 Feb.) had dropped nearly one foot, due to various factors, in the intervening 4 day period. |

| Reference wand | Location relation surface and levels of measured density (density holes of 8 February) | Location above 1950 firn surface (feet and inches) | (mm) | Measured distance between centers of reference wands | Compaction since 11 Feb. |
|---|---|---|---|---|---|
| surface | ------- | 11'4-1/4" | 3454 | | |
| 1. | 2'7" below snow surface due to combination of settling of this new surface snow layer (1-3/4") and to wind corrasion (9-1/4") and drifting. By these processes, a total drop in the surface of 11" occurred in this 4 day period. | 8'9-1/4" | 2667 | | |
| 2. | Base of d.h. No. 1 | 8'7" | 2616 | 2-1/4" | 1/16" |
| 3. | Base of d.h. No. 7 | 6'10-3/4" | 2108 | 1'8-1/4" | 1-3/16" |
| 4. | Base of d.h. No. 13 | 5'1-1/4" | 1549 | 1'9-1/2" | 1" |
| 5. | Base of d.h. No. 20 | 2'7-1/4" | 787 | 2'6" | 1/4" |
| 6. | Base of d.h. No. 29 | 0 | 0 | 2'7-1/4" | 3/8" |
| | | | | Total compaction between Wands 1 & 6 (4 days) | 2-7/8" |

B. Settling Rates in Fresh Snow on Horizontal Surface, pit B, Camp 10B.

Data from period of February 20-25, 1951. (In this period, 9-1/4" of surface snow were removed by wind corrasion.) In addition to the rates of settling, the initial positions of wands A-E, in respect to the current snow surface, are shown. These wands were inserted in the snow horizontally at the reference levels. (See locations in Table III.)

| | Wand A | Wand B | Wand C | Wand D | Wand E |
|---|---|---|---|---|---|
| | Initial depth below February 20th surface | | | | |
| | 3" | 1'3" | 2'3" | 3'3" | 4'3" |
| Hour Date | Settling Rates (mm) | | | | |
| 1345 2/20 to 2345 2/20 | 26 | 11 | 13 | 5 | 4 |
| 2345 2/20 to 1145 2/21 | 27 | 15 | 13 | 5 | 2 |
| 1145 2/21 to 2345 2/21 | 31 | 27 | 14 | 13 | 4 |
| 2345 2/21 to 1145 2/22 | 30 | 9 | 4 | -- | -- |
| 1145 2/22 to 2345 2/22 | 30 | 8 | 9 | -- | -- |
| 2345 2/22 to 1145 2/23 | 4 | 12 | 12 | 12 | 4 |
| 1145 2/23 to 2345 2/23 | 40 | 14 | 8 | 6 | 3 |
| 2345 2/23 to 1145 2/24 | 26 | 11 | 14 | 4 | 6 |
| 1145 2/24 to 2345 2/24 | 25 | 16 | 11 | 9 | 4 |
| 2345 2/24 to 1145 2/25 | 26 | 23 | 19 | 4 | 4-5 |
| 5 day total compaction | 265 (or 10.4") | 146 (5.7") | 117 (4.6") | 58 (2.3") | 31-32 (1.2") |

Note: The following amounts of new snow were added to the snow surface during this five day period:

On February 20th - trace
" 21st - 1/2"
" 22nd - 3-1/2"

On February 23rd-2"
" 24th-1/2"
" 25th-trace

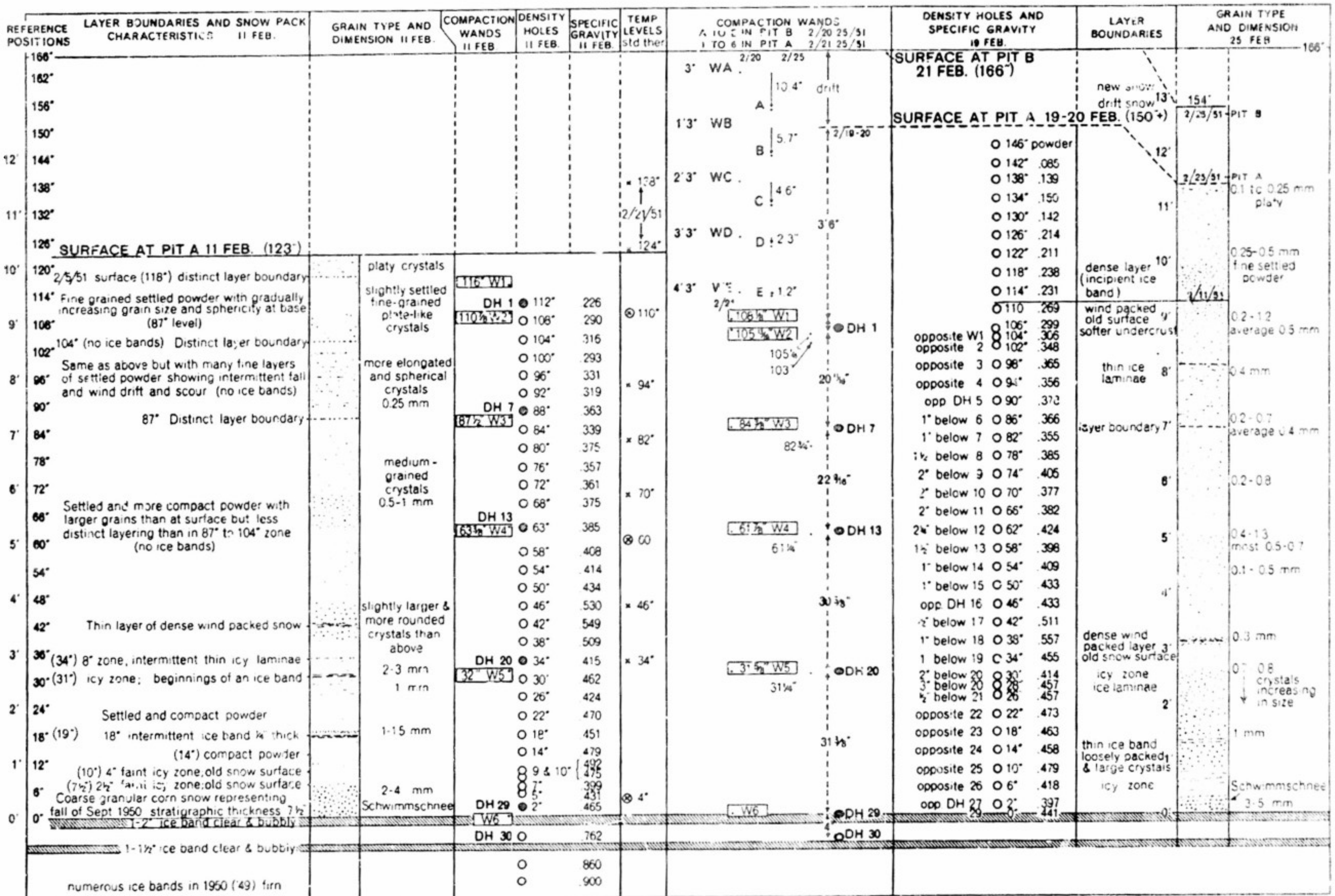



TABLE III. Stratigraphic and textural relationships in 1950-1951 winter snow cover, Camp 10B.

(c) Stratigraphic Relationships and Layer Characteristics

For a two week period at Camp 10B, a partial record of snow stratigraphy, grain characteristics, and other features was assembled. It is regretted that a longer or more continuous period of observation could not have been instituted so that a better comparison and a significant analysis of progressive changes in the snow profile could be made. The data listed in Table III are, however, probably representative of conditions in the snow cover on this glacier at any such mid-winter period. For comparative purposes, pertinent density values over nearly the same period and some data regarding snow compaction and settling are included.

As shown also by the facts in Section B2 (a) and Appendix H, a progressive, but somewhat irregular, increase in density and hardness exists at depth. This was also attended by a slight increase in grain size at depth which may be partially attributed to the higher temperatures under which initial accumulation and metamorphism occurred in the autumn and early winter layers. It was not possible to detect grain growth at any one level during the two week period of profile measurement. It is clear, however, that no prominent ice bands and few, if any, diagenetic ice structures had been formed in the autumn and winter snow layers up to the time of observation in February, although the presence of relatively harder and more impermeable (wind-packed) layers in the compact powder snow profile could be seen. These, plus a few of the very thin ice lamellae present in the lower part of the section, were likely incipient loci of future ice bands as the metamorphism of this snow pack into firn proceeded in subsequent months.

The high density of the previous year's firn beneath the 1950 (1949) reference level is of special interest here. This is attributed to two factors: (1) the sub-freezing conditions experienced at these depths during February (see Section B3 (b) of this report), and (2) the fact that actually the firn level at that depth represented the 1949 budget year, since at Camp 10B all of the 1949-50 accumulation had been removed by ablation up to September 1950. Thus, at this level, 1950 was a year with a net accumulation loss.

No detailed analysis of the data in these profiles is attempted in this report because our purpose has been primarily to present the facts. Whatever detailed interpretations are warranted will be drawn from a combination of these records and information obtained from late spring and summer studies at this and related locations.

(d) Absence of Free Water in the Mid-winter Snow Cover

On February 21, in pit A at Camp 10B, handfuls of water soluble fluorescein dye were scattered in wall recesses dug at the 18", 36", 60" and 110" levels below the surface of that date. The dye was employed on both the south and north walls of the pit. These recesses were left open to the air, but were shaded from direct sunlight. Two additional wall recesses, one at the 12" depth, and another at the 48" horizon, were filled with fluorescein powder and closed in with snow so that no direct atmospheric influences were in effect. On successive days until February 25th both the open recesses and those which had been enclosed were checked for the presence of solution and migration of this dye, either horizontally or

vertically, in accordance with the existence of any free water. During this period of observation, it was found that the powder remained in place and undissolved. During the five-day period, air temperatures at the surface of the glacier were well below freezing (10° to 20°F.) The temperature of the snow itself was likewise well below freezing for some tens of feet in depth. (See Section B3.) Thus, conditions may be considered to have been "polar" or high arctic in character, as far as the nature of snow metamorphosis and other changes during this period are concerned.

Some of the rounded grains in layers of settled snow in the profile at times of observation were not the result of melting. The sphericity of their crystals was rather a result of considerable abrasion of one particle against another during periods of wind storm and of drifting prior to their final deposition. For example, this situation was seen to prevail in the period during and immediately following the let-up of the severe blizzard on the 18th and 19th of February. Layers in the sequence of settled powder snow in which individual crystal facets could be clearly recognized were at levels which had apparently escaped the reworking action of wind via processes of deflation and subsequent re-deposition. This means they had been deposited at times of slight or no wind and heavy precipitation, so that they immediately became well buried in a relatively undisturbed manner. Because the subsequent temperatures at these snow levels had remained low, further growth of crystals had undoubtedly been retarded with the result that the major metamorphosis in this early stage of firn development was due to compaction. Most of the grains on the interfaces between distinctly different snow layers were rounded, indicating deposition or re-deposition and drift during periods of high wind. Although in a general way an increase in grain size with depth may be detected (Table III), the size of crystals in individual snow layers often seemed to bear little or no genetic relationship to depth. This was true at least in the 1950-51 snow deck.

As for the presence of mobile water during the winter months, it appears that englacially in and below the deeper parts of the firn and in the bottom parts of the glaciers themselves, there is some continuing water drainage. This was testified to by the fact that in January to March 1951, water could be seen flowing in the outlet streams from the low level termini of peripheral glaciers. This suggests that even in the highland areas, well covered by sub-frozen snow pack, unfrozen water is impounded at depth in holes and in the bottom of some of the deepest crevasses. Theoretically this is possible as long as the impounding is below the level of penetration of the winter cold wave. As shown in Figure 6, the seasonal chill at the 3,600 foot level did not seem to extend deeper than 70 feet below the mid-February snow surface in iced firn. Previous measurements of the depths of crevasses at this site showed the deepest ones to be as much as 40 feet deeper than the level of measured penetration of seasonal cold. Thus, impounded water in these larger fissures, although it may have a frozen surface, likely remains in the liquid state at the very bottom of the crevasse. From such perennial reservoirs slow drainage may continue to occur along periodic openings and fractures leading to deeper levels where the glacier is constantly at the pressure melting point. By virtue of this, sub-glacial drainage streams could be consistently fed throughout the year

by tricklings of water from the higher regions. Although, of course, in the winter months the volume of flow from this source is much reduced. Of supplementary interest is the fact that the field party working at Camp 10B in February occasionally felt a staccato shock as a result of adjustments in the glacier at depth. These sudden adjustments are probably accompanied by fracturing and the occasional opening up of new drainage channels along which such impounded waters, even in high winter, may well find an egress to lower levels and into sub-glacial outlet streams.

## (e) Chemical Analyses of Snow Samples for Chlorides

Samples of new snow, old snow, firn, and glacier ice, from the surface to depths as great as 276 feet, were obtained at Camp 10B during August-September 1950, in February 1951 and in June 1951. Chloride and sodium chloride analyses of the water from these samples were made by the project's chemist, Mr. H. J. Kothe, at the Fleischmann Laboratories in New York City. Mr. Kothe, a member of the 1950 field party, also aided in the collection of some of the samples in the field.

Decontaminated bottles, supplied by the A. H. Thomas Co., of Philadelphia and by Dr. Louis Ray of the U. S. Geological Survey, were used in collecting water samples. No distilled water was available. Where there was any doubt about the proper decontamination of bottles, they were carefully boiled in snow water, rinsed six times in some of the water to be collected and then, after filling, were sealed tightly with decontaminated corks.

It is of interest to note the relatively larger quantity of salines in the firn snow samples taken in the summer as compared to those taken at the surface in the winter; e.g., the samples taken in August 1950 and June 1951 as compared to those taken in February 1951. The calculated sodium chloride content at the August 1950 surface represents an increase of 15 times that of new winter snow analyzed at this same site in February 1951. This is undoubtedly, in part, related to the concentration of salts in the surface layers due to ablation, evaporation and downward melt water percolation, but it also may indicate an increase in wind blown oceanic vapors during these highly humid summer months. Cold and drier air, more continental in nature, is the rule in mid-winter. These winds would probably carry much less salines onto the ice field from the coast. The full significance of this and other variations in saline content, especially that in samples 1-7 (1950) has not yet been determined. However, results to date indicate that there is no significant change in chloride concentration with depth of sample.

All core samples (Table IV) were obtained from drill borings at Camp 10B in late August or early September 1950. Each sample was slightly dirty, i.e. it contained small amounts of dust, possibly washed from the air by rain, or wind-blown from nearby rock outcrops during the summer months. It is known that chloride in water may be derived from different sources such as mineral deposits, ocean vapors carried inland by the wind, or wind blowing over saline flats at low tide, and so forth.

The following table shows sample locations and reference levels for the data obtained and the chloride and sodium chloride analyses.

Table IV. Chloride-Sodium Chloride Content of Snow and Ice Samples, Camp 10B[28]

| Sample | Depth, 10B | Date | p.p.m. Chloride | p.p.m. NaCl[29] |
|---|---|---|---|---|
| A, gran. snow | 2-1/2' below surface | 8/ 9/50 | 4.5 | 7.4 |
| B, ice core | 110', drill hole 1 | 8/16/50 | 0.3 | 0.5 |
| C, " " | 243', " " 1 | 8/17/50 | 0.3 | 0.5 |
| D, " " | 276', " " 1 | 8/18/50 | 0.3 | 0.5 |
| 1, summer firn core | 25', " " 3 | 8/27/50 | 1.5 | 2.5 |
| 2, " " " | 60', " " 3 | 8/28/50 | 2.9 | 4.8 |
| 3, " " " | 75' " " 3 | 8/29/50 | 0.3 | 0.5 |
| 4, " " " | 100', " " 3 | 8/30/50 | 0.3 | 0.5 |
| 5, ice core | 125', " " 3 | 9/ 1/50 | 1.5 | 2.5 |
| 6, " " | 160', " " 3 | 9/ 2/50 | 2.9 | 4.8 |
| 7, " " | 170', " " 3 | 9/ 2/50 | 0.3 | 0.5 |
| 1, winter snow | at surface (fresh) | 2/14/51 | 0.3 | 0.5 |
| 2, " " | at surface | 2/18/51 | 0.3 | 0.5 |
| 3, " " | 3' below surface | 2/14/51 | 0.4 | 0.7 |
| 4, " " | 5-1/2' below surface | 2/14/51 | 0.3 | 0.5 |
| 5, " " | 8' below surface | 2/14/51 | 0.3 | 0.5 |
| 6, " " | 10-1/2' below surface | 2/14/51 | 0.3 | 0.5 |
| 7, "Schwimmschnee" (autumn 1950) | layer on top of 1950 summer firn surface. | 2/18/51 | 0.3 | 0.5 |
| 8, firn, 1949-50 | 4" below 1950 late summer ablation surface | 2/14/51 | 0.3 | 0.5 |
| 1, spring firn | 4' below surface | 6/11/51 | 0.4 | 0.7 |
| 2, " " | 8' " " | 6/11/51 | 0.3 | 0.5 |
| 3, " " | 12' " " | 6/11/51 | 0.3 | 0.5 |
| 4, " " | 16' " " | 6/11/51 | 0.3 | 0.5 |
| 5, " " | 20' " " | 6/11/51 | 0.4 | 0.7 |

[28] Procedure used for these analyses is the official method as described in "Standard Methods for the Examination of Water and Sewage", published by the American Public Health Association, 1936.

[29] p.p.m. : parts per million sodium chloride, calculated from the experimentally determined p.p.m. of chloride value.

3. Temperature Measurements in the Firn and Glacial Ice at Depth

By means of alcohol and electrical resistance thermometers, temperature measurements were obtained in the winter snow pack, in the underlying firn horizons and in levels of true glacier ice down to 170 feet below the February 21 surface (Figure 5). The results of measurements made in the winter snow pack with standard thermometers are presented first and then the data are listed as obtained from the thermistor records.

(a) Temperatures in the 1950-51 Snow Pack

At Camp 10B a Taylor alcohol thermometer and a standard Weather Bureau low temperature thermometer were used to obtain snow temperatures as noted below. For purposes of interpretation of this record, one is referred to the snow profile record in Section B, 2 (c) of this report. The reference horizon used was the top of the 1-2 inch ice band which positioned the surface of the 1950 (1949) firn. This reference horizon in February of course varied in depth beneath the current snow surface as a result of changes in that surface from repeated accretion, corrasion and settling of new snow. For part of the period, this is represented in Figure 7 and also in the following Table V. These data are necessary to any future interpretation of diurnal fluctuation of snow temperature which results from changes in ambient air temperatures. As shown in Table VI, which lists temperatures within the 1950-51 snow pack, corresponding air temperatures for most dates were recorded at the exact time of observation and at a level no more than two feet above the snow surface existent at the time.

TABLE V. Variations in depth of winter snow pack above the 1950 firn surface, Camp 10B[30]

| | | | |
|---|---|---|---|
| 5 February 1951 | 117" | 14 February 1951 | 127" |
| 7 February 1951 | 118" | 15 February 1951 | 145" |
| 8 February 1951 | 121" | 16 February 1951 | 153" |
| 9 February 1951 | 123" | 17 February 1951 | 165" |
| 10 February 1951 | 123" | 18 February 1951 | 168" |
| 11 February 1951 | 123" (-) | 19 February 1951 | 178" (+) |
| 12 February 1951 | 122" | 21 February 1951 | 166" |
| 13 February 1951 | 124" | 25 February 1951 | 154" |

[30]Approximate net values due to irregular and variable effects of corrasion, drifting and settling. These values were taken from only one site near Camp 10B. The measurements for other sites even only a few tens of yards away sometimes produced different sums; e.g., in Table III, column 8, see differences in measured accumulation at pits A and B.

Table VI. Temperatures within the 1950-51 Snow Pack in February 1951, Camp 10B

(Standard Alcohol Thermometer Readings in °C.)

| Date Feb. | Hour | Ambient Air Temp.[31] | Temp. Record Horizon above 1950 Firn Surface.[32] 138" | 124" | 110" | 94" | 82" | 70" | 60" | 46" | 34" | 4" |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 1630 | -18.0 | | | -17.5 | -12.0 | -10.2 | -9.2 | -8.2 | | | |
| | 1730 | -22.0 | | | -18.0 | -17.5 | -12.0 | -9.0 | -8.2 | | | |
| 7 | 1500 | -15.2 | | | -17.8 | -13.0 | -10.0 | -8.5 | -8.5 | -5.3 | -5.1 | |
| 8 | 1100 | -15.0 | | | | | | | | | | |
| | 1600 | -11.0 | | | | | | | -8.0 | | | |
| | 2000 | -15.0 | | | | | | | -10.5 | | | |
| 9 | 1930 | -30.3 | | | | | | | -13.5 | | | |
| | 2000 | -30.3 | | | | | | | -13.3 | | | |
| 10 | 1100 | -24.2 | | | | | | | -16.4 | | | |
| | 1900 | -27.2 | | | | | | | -16.2 | | | |
| 11 | 1000 | -22.0 | | | | | | | -16.3 | | | |
| | 1200 | -15.0 | | | | | | | -16.0 | | | |
| 12 | 1000 | -24.3 | | | | | | | -15.8 | | | |
| | 1700 | -22.0 | | | | | | | -15.2 | | | |
| | 1800 | | | | -13.4 | | | | -16.8 | | | -10.4 |
| | 2000 | | | | -21.3 | | | | -13.3 | | | -10.0 |
| | 2200 | | | | -19.2 | | | | -12.1 | | | - 9.3 |
| 13 | 0800 | | | | -21.5 | | | | -13.2 | | | -10.4 |
| | 1000 | | | | -18.2 | | | | -12.3 | | | -10.2 |
| | 1200 | | | | -22.5 | | | | -12.3 | | | -10.4 |
| | 1400 | | | | -23.1 | | | | -12.5 | | | -10.7 |
| | 1600 | | | | -23.1 | | | | -12.6 | | | -10.8 |
| | 1800 | | | | -23.0 | | | | -12.5 | | | -10.8 |
| | 2000 | | | | -23.0 | | | | -12.5 | | | -10.8 |
| | 2200 | | | | -22.0 | | | | -13.2 | | | -12.5 |
| 14 | 0800 | | | | -21.2 | | | | -11.3 | | | - 9.9 |
| | 1000 | | | | -14.3 | | | | -10.5 | | | - 8.9 |
| | 1200 | | | | -16.4 | | | | -11.1 | | | - 8.9 |
| | 1400 | | | | -17.2 | | | | -13.1 | | | - 9.9 |
| | 1600 | | | | -16.8 | | | | -12.2 | | | -10.5 |
| | 1800 | | | | -16.0 | | | | -12.0 | | | -10.2 |
| | 2000 | | | | -16.0 | | | | -12.0 | | | -10.1 |
| | 2200 | | | | -15.9 | | | | -11.9 | | | -10.0 |
| 20 | 1730 | | -10.8 | -9.3 | - 8.7 | - 8.6 | - 9.1 | -9.0 | - 8.5 | -8.3 | -7.8 | - 7.6 |
| 21 | 1030 | -21.0 | - 9.7 | -8.1 | - 8.7 | - 8.5 | - 9.3 | -9.1 | - 8.7 | -8.4 | -7.4 | - 7.2 |
| | 1100 | | - 9.2 | -8.3 | - 7.8 | - 6.4 | - 9.2 | -9.1 | - 9.0 | -9.2 | -8.7 | - 7.8 |
| | 1400 | | | | | | - 8.5 | | | | | |

[31]For the exact position where these air temperatures were taken, see Table I, keeping in mind that all readings were made within two feet of the snow surface at the time of observation. Also for minimum daily temperatures and other pertinent meteorological factors, refer to climatological records listed in Appendix and those more detailed records on file at the Am.Geog.Soc.

[32]Note comparison of these data from alcohol thermometers with those obtained by the use of electrical thermistors which were also employed in the snow pack. The thermistor records are discussed in the next section of this report and are listed in the Appendix.

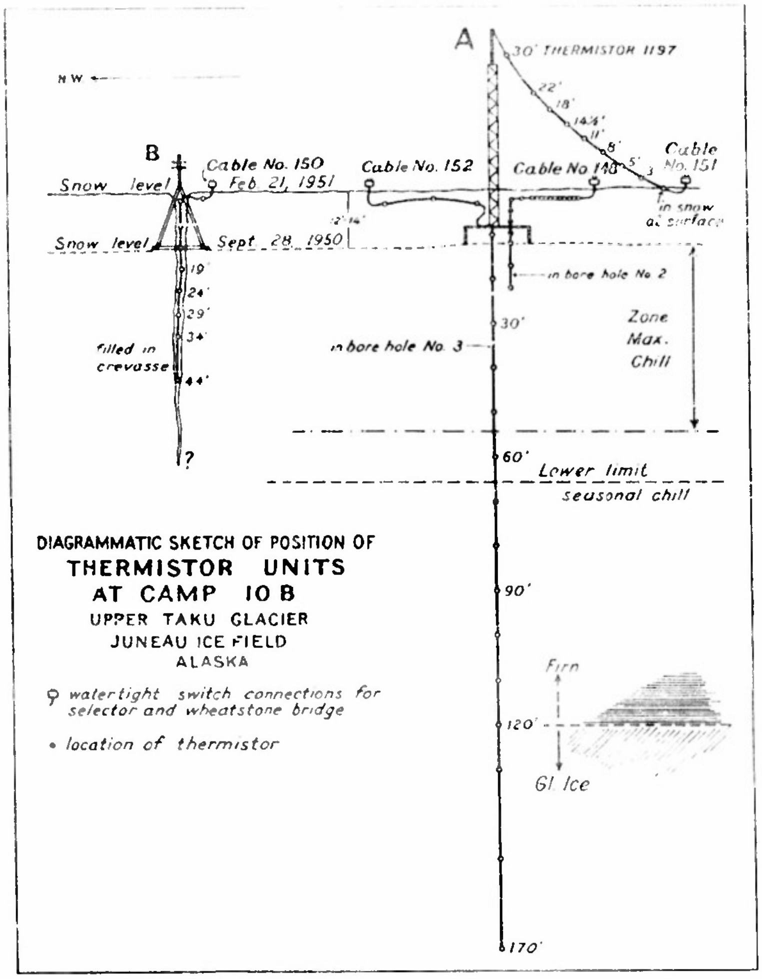



FIG. 5. Diagrammatic sketch of position of thermistor cables and units.

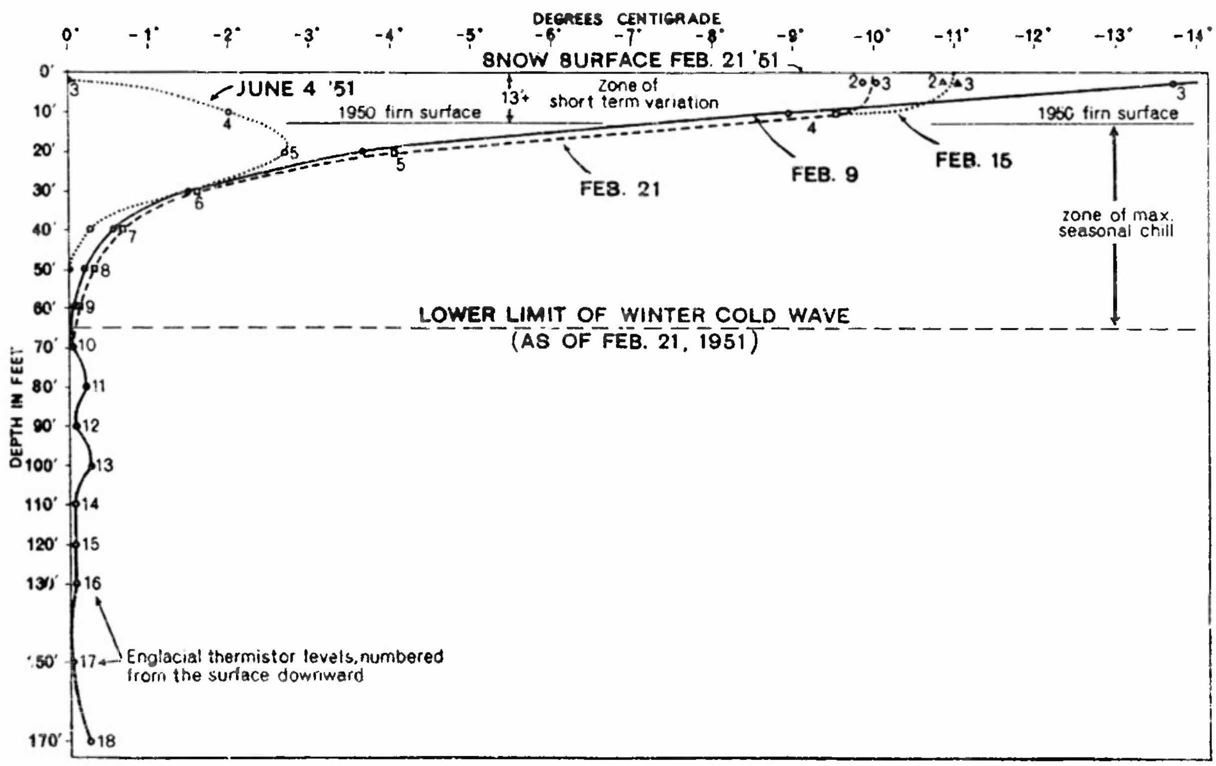



FIG. 6. Englacial temperature variations at Camp 10B.

(b) Englacial Temperature Records from Thermistor Cables

The U. S. Geological Survey, through the cooperation of its Baltimore Geophysical Laboratory, provided this project in the summer of 1950, with 6 sets of spaced temperature recording thermistors to be used for obtaining englacial temperature data in new snow, in firn and in ice at depth. Special advice concerning their use and assistance in the interpretation of the resulting records have been kindly given by Dr. Joel H. Swartz, geophysicist in charge of the above mentioned office of the Geological Survey.

The cables used are similar to the type employed by the Geological Survey in connection with the permafrost studies near Pt. Barrow, Alaska.[33] To our knowledge, their specific application to glacier studies is one of the first on record.[34] The thermistor element consists of an alloyed semi-conductor, characterized by a 4.4 percent negative change in electrical resistance per degree Centigrade change in temperature. Measurements can be made with an accuracy up to 1/100th of a degree Centigrade by means of a specially-designed, Leeds and Northrup Wheatstone bridge which registers the resistance of each thermistor. For good results, proper calibration is important.

In this regard, Dr. Swartz advises that "we have absolutely no reason to believe that the thermistors suffer any decrease in accuracy with time. However, there does appear to be a very slow drift in calibration with time. We are studying the effect right now with the aid of a series of calibrators by the Bureau of Standards over a period of one and one-half years....The drifting is very slow and apparently fairly uniform, although our data are still insufficient---for any conclusive statement.... The Taku Glacier thermistors should normally not need replacement, but may, after a year or so, need recalibration for 0.01° accuracy."

Dr. Swartz advises that we may take measurements throughout a summer season and recheck the calibration at the end of the season. The recalibration on such equipment could be accomplished first, by burying the thermistors in a good ice bath at the firn surface (0°C) and checking the zero value after a sufficiently long immersion to insure that thermal equilibrium has been attained. This ice bath could be made of compressed firn of uniform crystal size. The firn should be packed around the thermistors with a clean wooden paddle and made absolutely tight. When the ice particles (or firn) are pressed against the thermistors it must create a darker shade (by pressure melting) to insure good thermal contact. All

[33] Black, R. F., "Permafrost", Chapter 14 in 'Applied Sedimentation', Edited by P. D. Trask, Wiley, New York, 1950, pp. 247-75.

[34] The writer understands from a recent conference in Paris with members of Expeditiones Polaires Françaises that their 1951 expedition employed thermistors with some success for temperature measurements at depth in the Greenland Ice Cap.

water should be drained off. By using such care adequate calibration accuracy should be attainable. Further, to insure accuracy, readings should be taken over a period of time in the ice bath, and final values should be accepted only after they have reached, and held constant for some time, their asymptotic value.

Also pertinent to the considerations of time variation in thermistors is the following information given by M. C. Brewer, geophysicist in the U.S.G.S. Baltimore Laboratory:

"Regarding the possibility of thermistor 'drift', we have several 100-foot cables at Barrow that were installed approximately two years ago and have been read weekly since that time. The readings were taken with special care, and we now have over one year's record that we feel is completely free of spurious errors. During that period of time a very gradual change in resistance of 4 to 6 ohms was noted. We are not in position at the present time to say whether this was an actual temperature change or whether it was possibly a drift in the resistance of the thermistors. We do feel, however, that these thermistors located between 70 and 100 feet in these holes are in one of the best and most reliable 'constant temperature baths' in existence. As a result of this information, I do not believe that anything can be definitely said about 'drift' in normal thermistors at this time. We do suspect that it may exist, but if it does it is so small as to pass unknown except in long and very detailed investigations."[35]

With the thermistor units used on the Taku Glacier, a 30-contact selector switch permits any one of 30 thermistors on individual wires within the cables to be cut in singly and directly. The resistance of any single thermistor is then compared in the calibration table, and its corresponding temperature read. The following strings of cables were provided for the project. Further details concerning the spacing of each, the lead resistance, selector switch reference, and so forth, are given in Appendix I. The location of each cable system as used is described below. (Note Figure 5.)

Cable No. 148 — 35 foot cable; 7/10" vulcanized cable, with 15/16" thermistor units; 19 individual thermistors; located in the top of Drill Hole No.2; implanted August 1950; upper segments attached to aluminum marker tower at Camp 10B. Purpose: to provide measurements in the winter snow layers of 1950-51 and in the 10 feet of firn below the 1950 late summer snow surface.

Cable No. 149 — 35 foot cable, same type as No. 148; employed in subsequent season.

[35]From personal communication.

Cable No. 150 — 50 foot cable; narrow wire and small units; 9 thermistors spaced five feet apart for the first 40 feet and the last two, 10 feet apart; location in 1950 and 1951 in narrow crevasse below tower B, Camp 10B (Figure 5); top three thermistors above 1950 late summer firn level. The remaining 30 feet of cable hung vertically downward in a filled-in crevasse (most likely re-opened by subsequent movements in 1951). Units were initially packed solidly in this crevasse with shoveled snow.
Purpose: for englacial temperature readings both in winter snow layers 1950-51 and in previous years of firn ice to 44 feet below Feb. 21 snow surface; also to record temperature effects in a crevasse zone.

Cable No. 151 — 50 foot cable, same as No. 150 (narrow wire and small units); used for surface atmospheric temperature measurements and attached to aluminum reference tower (Camp 10B, 1950-51) and thus up to 30 feet above Feb. 21 snow surface. (See Figures 5 and 7.) Note discussion in Section A8 of this report.
Purpose: to provide temperature readings in katabatic air layers above glacier surface in following increments; in snow, at surface; in air, at heights of 3, 5, 8, 11, 14-1/2, 18, 22, and 30 feet.

Cable No. 152 — 200 foot thermistor cable; 18 individual units spaced 10 feet apart for the first 160 feet (to 130 feet below Feb. 21 snow surface) and the last two, 20 feet apart (thus to 170 feet below Feb. 21 snow level); implanted Sept. 10, 1950 in vertical position in Drill Hole No.3, Camp 10B (Figure 5); cable and units firmly packed in snow (held in by thin paper shield) before lowering into drill hole. This was done to prevent circulation of air in hole around thermistors at depth and to form a tighter fit in the drill hole. It is believed the only possibility of external influences obscuring the true readings could be caused by the 245 feet of 2-inch aluminum pipe, which was left in Drill Hole No. 1 at a horizontal distance of six feet away. (The great weight of the mechanical drill rig used in boring precluded its being shifted any farther from the drilling site of these holes.)
Purpose: to provide englacial temperature data at depths down to 170 feet below the Feb.21 snow level (or 157 feet below the 1950 firn surface).

Cable No. 153 — 400 foot cable (narrow wire and small units); 18 individual units, spaced 20 feet apart up to 200 feet and 25 feet apart between 200 and 400 feet; not as yet installed (1951); however, it is anticipated that this cable will be implanted in the glacier in a subsequent season by an electro-thermic "hot point" drilling technique. It may then be read periodically by future field parties to obtain comparative data on the theoretical calculation of the pressure melting temperature of ice down to 400 feet (supposedly a reduction of about nearly -0.1°C. at this depth). It also should provide further information on the seasonal winter cold wave.

(c) Results from Thermistor Data

Temperature readings were obtained within the upper Taku Glacier with the above described equipment on a more or less continuous schedule between the 9th and the 24th of February, 1951. As shown in Figure 5, the thermistor cables employed in the englacial investigations were numbers 148, 150 and 152. The tabulated results of these readings are given in Appendix J. (The data from Cable No. 151, which was used in connection with the micrometeorological program, as has already been mentioned, are in Appendix G.) To aid in the detailed analysis and interpretation of these records, the following essential details in regard to the measurements are given.

1. Notes on the Use of Thermistor Cable No. 150

This cable was buried in a vertical position in a narrow filled-in crevasse, about 60 feet northwest of the aluminum reference tower (A in Figure 5) at Camp 10B. The top two thermistors on this cable were taken off the 18 foot wooden tower (tower B, Figure 5), which in the previous September had been erected above this point and on the late summer 1950 ablation surface. This meant that the thermistors at the 5 foot (No. 1179) and 10 foot (No. 1180) levels at the top of the cable were left resting two to four feet beneath the late February 1951 snow surface. The data from these upper thermistors, therefore, should essentially reflect variations in surface atmospheric temperature. Thermistor 3 (No. 1181) rested 5 feet above the 1950 firn surface and thermistor 4 (No. 1182), 20 feet from the top of the cable, remained directly on the 1950 ablation (firn) surface. This means that 30 feet of the temperature record below this 1950 late summer surface were recorded by thermistors 5 to 9 (Numbers 1183 to 1187) (Appendix J).

Temperature records were obtained on this profile at least once a day on the following days: on February 9th, p.m.; on February 14th, p.m.; on February 18th, a.m.; on February 19th, early and late p.m.; on February 20th a.m. and early and late p.m.; on February 21st, a.m. and p.m.; on February 24th, p.m.; and on February 25th, p.m. There is close agreement in readings taken in the morning, afternoon and night, at and below No. 1182, which was 20 feet from the upper end of the cable and exactly at the 1950 firn level. Thus, the zone affected by short term temperature variations is limited at approximately this depth, 12 to 14 feet below the February 21 snow surface (Figure 6). The resistance of thermistors 2 and 3 (Numbers 1180 and 1181) on this string varied enough to prove their positions (3 to 8 feet below the February 21 snow level) were well within the zone which suffered short term changes under influence of diurnal variations in surface air temperature.

As shown in Figure 6 temperatures plotted from such data indicate provisionally that the lower limit of seasonal penetration of the winter cold wave can also be determined at that point where the temperature gradient (in ice at depth) approached 0°C. This limit appears to lie at 60 to 65 feet below the February 21 reference surface (see Figures 5 and 6). The record from Cable No. 150 is of special interest because it was made in a narrow crevasse which at the time of cable implanting was filled with snow by several days of shovelling and tamping. This was done in order to minimize circulation of atmospheric air currents in the fissure which otherwise would directly affect the variation of these englacial readings. Thus, in effect, this cable was sealed in a natural hole in the glacier which subsequently was further covered by autumn and winter snowfall.

The significance of the record from Cable No. 150 will be discussed in a later report, but for purposes of interpretation, two factors should be reiterated: (1) that this cable was implanted in a very narrow crevasse which might have opened up at depth beneath the winter snow cover due to adjustments in the glacier,[36] and (2) that this cable would suffer no influence from the proximity of any foreign material in the ice (such as the aluminum pipe near Cable No. 152).

2. Notes on Thermistor Cable No. 152

This 200-foot length of cable, with 18 individual thermistor units, had its top three thermistors located respectively 3 feet 7 inches, 2 feet, and 2 feet 6 inches below the February 21 reference surface. Essentially, as with Cable No. 150, the record from these roughly horizontal-lying, upper thermistors fully reflects variations in atmospheric surface temperature. The lower 157 feet of cable lay below the top of the 1950 firn surface. Thus, the over-all record provides us with data on englacial temperatures down to at least 170 feet below the February 21 surface. Records were obtained between the 9th and 24th of February as follows: on the 9th, p.m.; on the 14th, p.m.; on the 15th, a.m.; on the 17th, p.m.; on the 19th, early and late p.m.; on the 20th, a.m. and early and late p.m.; on the 21st, a.m. and p.m.; and on the 24th, p.m. From the tabulated thermistor readings in Appendix J can be noted a marked agreement in readings on all thermistors below Thermistor 5 (No. 1251, 50 feet from the upper end of the cable), which was 20 feet below the mid-February snow level and at least 7 feet beneath the 1950 firn surface.

Thermistor 4 (No. 1240, 40 feet below the upper end of the cable and thus at, or just beneath, the level of the wooden drill platform) lay about 3 feet above the 1950 late summer firn surface. It reflected less change due to surface variations of air temperature than either thermistors 2 or 3; however, it did vary enough to show that its position also was well within the "active" zone affected by short term atmospheric thermal variations.

Because Thermistor 5 continually showed the same reading within 1 or 2 ohms, both day and night between the 9th and 24th of February, it was clearly in a much more thermally stable zone at this time of year. Its temperature, however, was still 4-5 degrees lower than that found at 17 feet below the 1950 firn level (Thermistor 6, No. 1242 ). Since consecutive readings at 17 feet, 27 feet and so forth down to 157 feet below the 1950 surface were more consistently in agreement, it can be stated that the base of the seasonal (winter) chill zone at that time rested somewhere between 55 and 65 feet below the February 21 snow surface. A diagrammatic representation of this winter cold zone and the lower limit of diurnal and short term temperature variations is given in Figure 6. This figure also illustrates in detail the nature and extent of these temperature variations at depth.

[36] As suggested by the sudden englacial movements felt by the field party at this site in February.

Thus, the readings from Cable No. 152 are primarily of value in the study of the magnitude and the depth of penetration of the seasonal cold wave. The upper thermistors may have been influenced by their proximity to the metal of the aluminum tower, but this effect is believed to be small.

3. Notes on Thermistor Cable No. 148

The readings from Cable No. 148 are probably not of as much value in the determination of thermal regimen. In addition, because of their nearness to the aluminum tower, at least above the 1950 firn level, the readings may be somewhat inaccurate. This aspect may be partially clarified by comparison of the records in Appeidix J with those obtained with alcohol thermometers as given in Table VI in Section B3 (a) of this report. No attempt is made at this time to evaluate this consideration.

No matter what the detailed analysis may bring out, measurements from this string of thermistors will reflect to some extent the depth of influence of changing surface air temperatures. In addition, the results from those thermistors, as in Cable No. 152, which lie below the 1950 surface will also be of value. The top thirteen thermistors of Cable 148 lay buried horizontally along the surface of the snow on February 9th. (They had been taken down from the tower to facilitate readings at the lower levels.) We may assume that they were 2 to 4 feet below the mid-February to February 21 snow surface. This means that 15 feet from the upper end of the cable and along it to 35 feet, the line of thermistors projected vertically downward into the previous summer's iced firn. This provided about 20 feet of recordable data, approximately the lower 10 feet of which represents a record within the 1950 firn.

A closer accordance of readings, over the period of observation, was obtained on corresponding thermistors of this cable from the point 10 feet below the 1950 layer up to the 1950 firn horizon than was the case with those thermistors above this level. Such agreement bears out the diurnal and short period relationships shown in Figure 6, the data for which were taken from the readings of Cable No. 152 on the 9th, 15th and 21st of February.

(d) Significance of Englacial and Firn Temperature Records

Figure 6 has been drawn from a preliminary analysis of the thermistor data described above. It is possible that further detailed study of the temperature records for each date of observation may modify the few conclusions here presented. In summary, it may now be said that on February 21 the lower limit of the seasonal cold (winter chill) layer in the Taku Glacier at Camp 10B had penetrated to at least 55 feet and possibly more than 65 feet. It is also apparent that the effects of diurnal changes in ambient surface temperatures, in response to local and regional meteorological factors over short periods of time, were not significant much below the horizon of the 1950 firn surface. This was 13-14 feet below the February 21 snow surface. It may be that the basal ice band zone and the great increase in density at the 1950 firn level (see Table III, column 5) served as an effective temperature barrier to all minor thermal oscillations in the 1950-51 winter snow pack.

1. Stability of Winter Chill Zone

Although no attempt at final conclusions is made here, it is of preliminary interest that a definite zone of maximum and relatively stable winter chill (up through February) existed in the Taku Glacier at this site between the 14 foot and at least to the 55 foot levels beneath the snow surface of February 21. How stable this zone actually is in terms of normal conditions is not yet known. During the period of observation, however, from February 9th to 21st there was a noteworthy consistency in record. The lowest temperature recorded in this zone (below the 1950 firn surface to the 55 foot level) was -9.0°C.(15.8°F.). Between the 9th and the 21st of February at the 1950 firn horizon, the temperature had decreased approximately 1°C., or from -8°C. to -9°C. At the 50 foot depth, it changed only 0.1°C., or from -0.16°C. to -0.27°C. This suggests a fair stability, but at the same time shows that as of February 21 the zone of maximum chill was still decreasing in temperature from the seasonal effect. Since from the meteorological appendix to this report it is shown that in the next few weeks in March (after the evacuation of the expedition) regional temperatures had begun to warm up, it is probable that this late February temperature record at depth approached the minimum for the year. The approximate nature of thermal changes in early June is indicated in Figure 6 by dotted line. By June 16, 1951, the sub-freezing winter chill zone was dissipated, and the glacier had essentially reached thermal equilibrium at its pressure-melting point.

2. Short Term Temperature Variations throughout the 1950-51 Snow Pack

It is suggested by these foregoing data that the whole of the snow pack on the 1950 firn surface at this location was subject to daily and weekly variations in response to changes in ambient air temperatures above the glacier's surface. The detailed study of these relationships must include a close analysis of the contemporaneous meteorological records obtained at the surface of the glacier during the period of observation, as well as a check reference to the temperature readings made with standard thermometers in the winter snow pack. (See Table VI, Section 3 (a).) Preliminarily, it may be mentioned that a great range of fluctuations in the surface snow layers seems probable. This is shown by effects on the snow temperature gradient of representative negative surface air temperature variations as plotted in Figures 6 and 8.

4. Glacier Surface Movement Records

(a) Mid-winter Surface Movement Data at Camp 10B

The 1950 summer transit Station 10B (approximately 3600 feet elevation) a few feet west of the surface position of the aluminum pipe at Camp 10B was reoccupied on February 6. (Its February 1951 position is designated Station 10B'.) A complete round of sights was obtained with a mountain transit on loan from the U. S. Forest Service in Juneau. (See tabulation below.) All readings taken from it were obtained in degrees and minutes to right or left of a line of sight to Station 19 at Camp 10.

These data were supplemented by repeated readings on the 20th and 26th of February. This allows exactly three weeks of record (21 days) for the determination of surface movement of the glacier at this point. We also have a comparison of the horizontal surface position of this station with respect to previously fixed bedrock stations. The summer coordinates and elevation of the station (10B) were also established in 1951. Thus, a comparison of relative surface movement on the Taku Glacier at this point can be calculated for corresponding periods in the summer and winter months and for the total annual displacement. The station numbers and names listed are those applied in the Survey Reports of 1949 and 1950.[37]

| From Station 10B′ | 6 Feb.'51 | 20 Feb.'51 | 26 Feb.'51 |
|---|---|---|---|
| To Station 19 (Camp 10; 3862 ft.) | 0° | 0° | 0° |
| To Sta. Hodgkins (5912 ft.) | R. 71°54' | R. 72°11' | R. 72°15' |
| To Sta. 34 ("Exploration Peak"; 5907 ft.) | L. 35°47' | L. 35°33' | L. 35°25' |
| To Sta. 23A ("North Echo Peak"; 5430 ft.) | L. 89°49' | L. 89°28' | L. 89°20' |
| To "North Taku Tower" (6805 ft.) | L.158°47' | L.158°20' | L.158°15' |
| To Sta. 22 ("Slanting Peak"; 5212 ft.) | R.133°47' | R.134°09' | R.134°18' |
| To Sta. 21 ("Juncture Peak"; 4379 ft.) | R.164°4' | R.164°33' | R.164°42' |
| To Sta. 24 ("Vantage Peak"; 5594 ft.) | No reading | R. 14°30' | R. 14°51' |
| To Aluminum Pipe (Camp 10B) | No reading | R. 16°30' | No reading |

[37] See Mapping and Survey sections in, Miller, M.M. "Scientific Observations of the Juneau Ice Field Research Project, Alaska 1949 Field Season" Juneau Ice Field Research Project Report No. 6, American Geographical Society, July 1952.

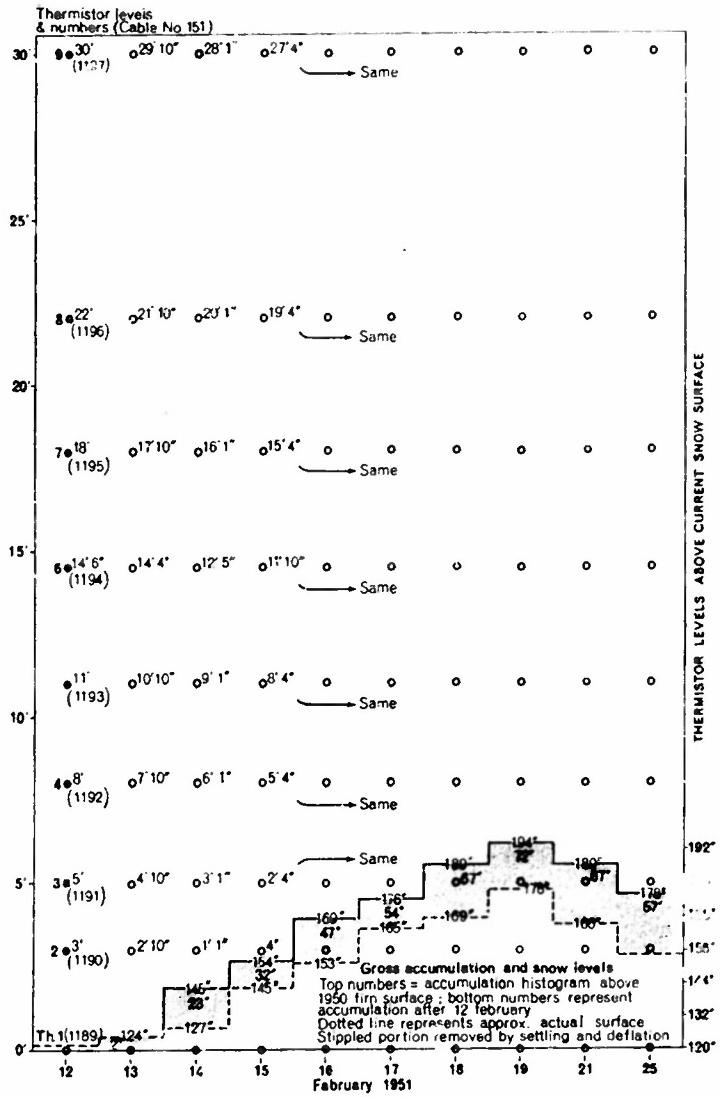



FIG. 7. Diagrammatic representation of relative temperature record levels on Camp 10B antenna mast.

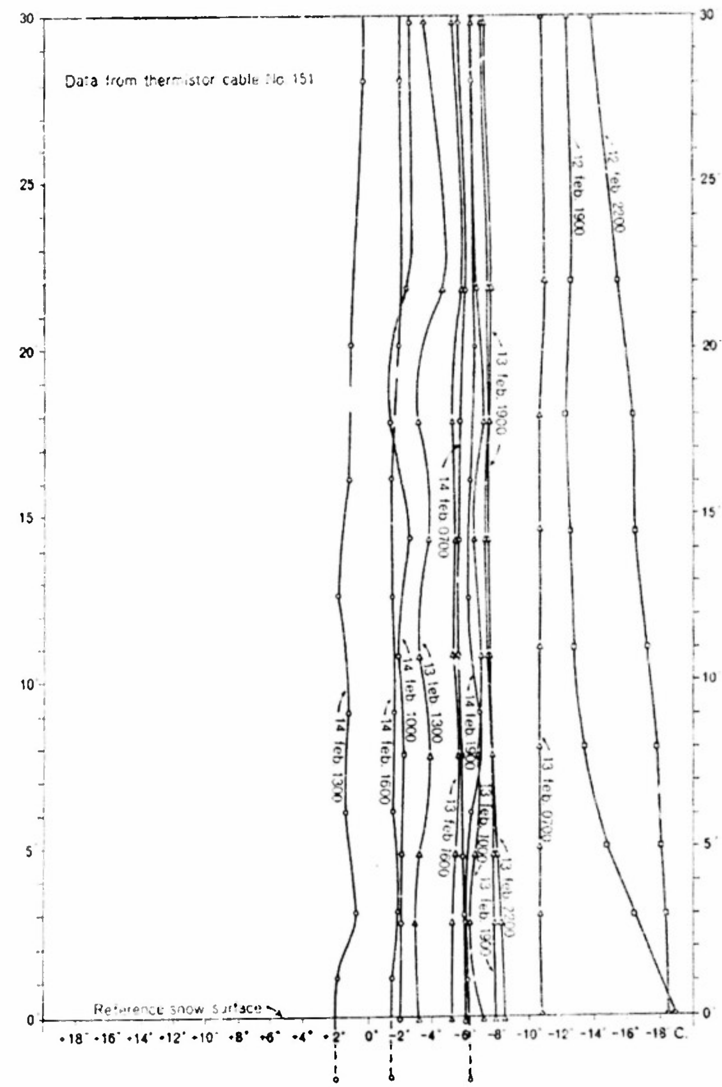


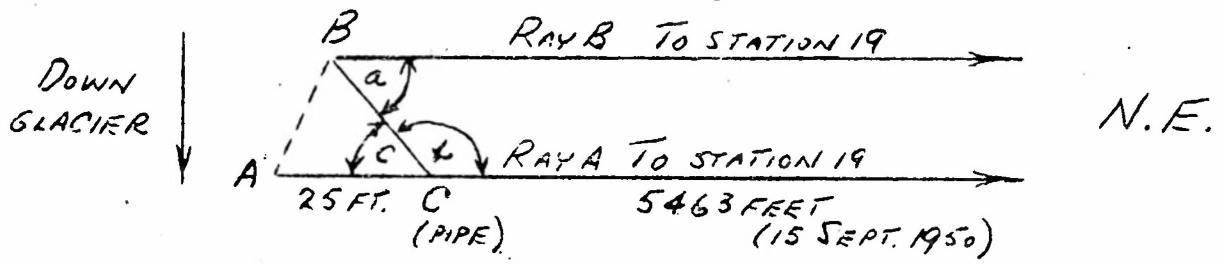

FIG. 8. Sample distribution of surface air temperatures to 30 feet above mid-February snow surface. Camp 10B.

(b) Calculation of Taku Névé Surface Movement, September 1950-February 1951

Using the angle between the rays from Station 10B (February 1951) and Station 19, and from Station 10B (February 1951) and the aluminum pipe (see section B5 of this report), it is possible to make some useful calculations. One of these is the absolute horizontal position which Station 10B occupied in February 1951 in relation to its absolute horizontal position of September 1950. These two different positions are the result of displacement due to the movement of the glacier during this five month period.[38] From this displacement, the surface location and lateral movement of the top of the nearby aluminum pipe at Camp 10B are known. The following calculations have been suggested by C.R. Wilson, who as a member of the 1950 survey team helped to establish the triangulation network which is here employed.

Given: a = 16°30'
BC = AC = 25 feet
Distance C to Sta. 19 = 5463 feet
(by triangulation)

A = 15 Sept. 1950 relative horizontal position of stake (10B)
B = 20 Feb. 1951 absolute horizontal position of stake (10B)




I. construct figure above by making ray A parallel to ray B and measuring the angle a.

II. since ray A is parallel to ray B then: b = 180 - a and c = 180 -b; c = 180 - (180 - a); c = a.

III. distance in feet between two stakes d:

$\frac{d}{2} = 25 \sin \frac{c}{2}$; $d = 50 \sin 8°15'$

$d = 50\ (.1435)$ $\therefore$ $d = 7.18$ feet

Analysis of significance of error in this method of finding d:

I. Since in reality ray A is not parallel to ray B, the angle b will be: b = 180 - a - E where E is the angle between the two stakes as seen from Station 19.

[38]Vertical angles were obtained in the summers of 1950 and 1951, from which the change in surface elevation of the top of this pipe may be calculated for the intervening years.

II. Given the distance A to Station 19 as 5488 feet and since d is about 7 feet, the angle E can be found:

$$E = \frac{7 \text{ ft.}}{5488 \text{ ft.}} = .001278 \text{ rad} = 1.278 \times 10^{-3} \left(\frac{180}{\pi}\right) = 7.3 \times 10^{-2}$$

E = 4.4 minutes of arc

III. Thus, the value of b is:

b = 180 - 16°30' -4.4' = 163°25.6'

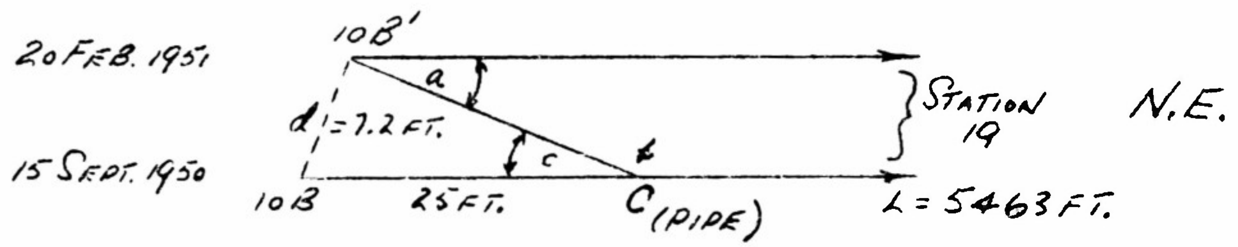
and thus the value of c is:

$$\begin{array}{r} 179°60' \\ -163°25.6' \\ \hline 16°34.4' \end{array} \qquad c = 16°34.4'$$

IV. The value of d is then:

$$d = 50 \sin \frac{16°34.4'}{2} = 50\ (.1441) = 7.21 \text{ feet}$$

V. Thus, the error introduced by assuming A parallel to B is 7.21 -7.18= .030 feet, which for purposes of this calculation is negligible. For further calculations d is hereafter referred to as 7.2 feet.




A source of probable minor error which cannot be completely eliminated is the initial assumption that the September and February movement stakes were exactly equidistant from the pipe. These measurements were made by means of a tape, but the nature of field conditions and the snow surface at each of these times was such as to introduce possible inaccuracies. In each instance, however, the positions of the stakes were quite close together and lined-up roughly along the sighting ray (hence the low angle of difference) which passes through the pipe and Station 19. For this reason inaccuracies in chaining the distance would not introduce any great errors into the calculations.

VI. Changes in the horizontal position of the top of the aluminum pipe, during the winter period of observation and subsequent to the previous summer, may also be calculated by trigonometric means. The basic figures and results of these calculations are given below. Some of the angle and distance figures shown have been taken from the triangulation network of the 1949 and 1950 seasons. The calculation of the shift in position of Station 10B from September 15, 1950 to February 26, 1951 gives a velocity of 1.86 feet per day over this 143 day period. The average velocity for this 5 month period, interestingly enough, is quite close to the summer rate of Movement Stake III (1.82 feet per day) on the 1950 movement profile a few hundred yards north of this site. It is interesting that the velocity obtained for the twenty-one days observed in February is somewhat higher than that for a corresponding period in mid-summer.

The following table refers to the horizontal surface position of the top of the aluminum pipe, Camp 10B:

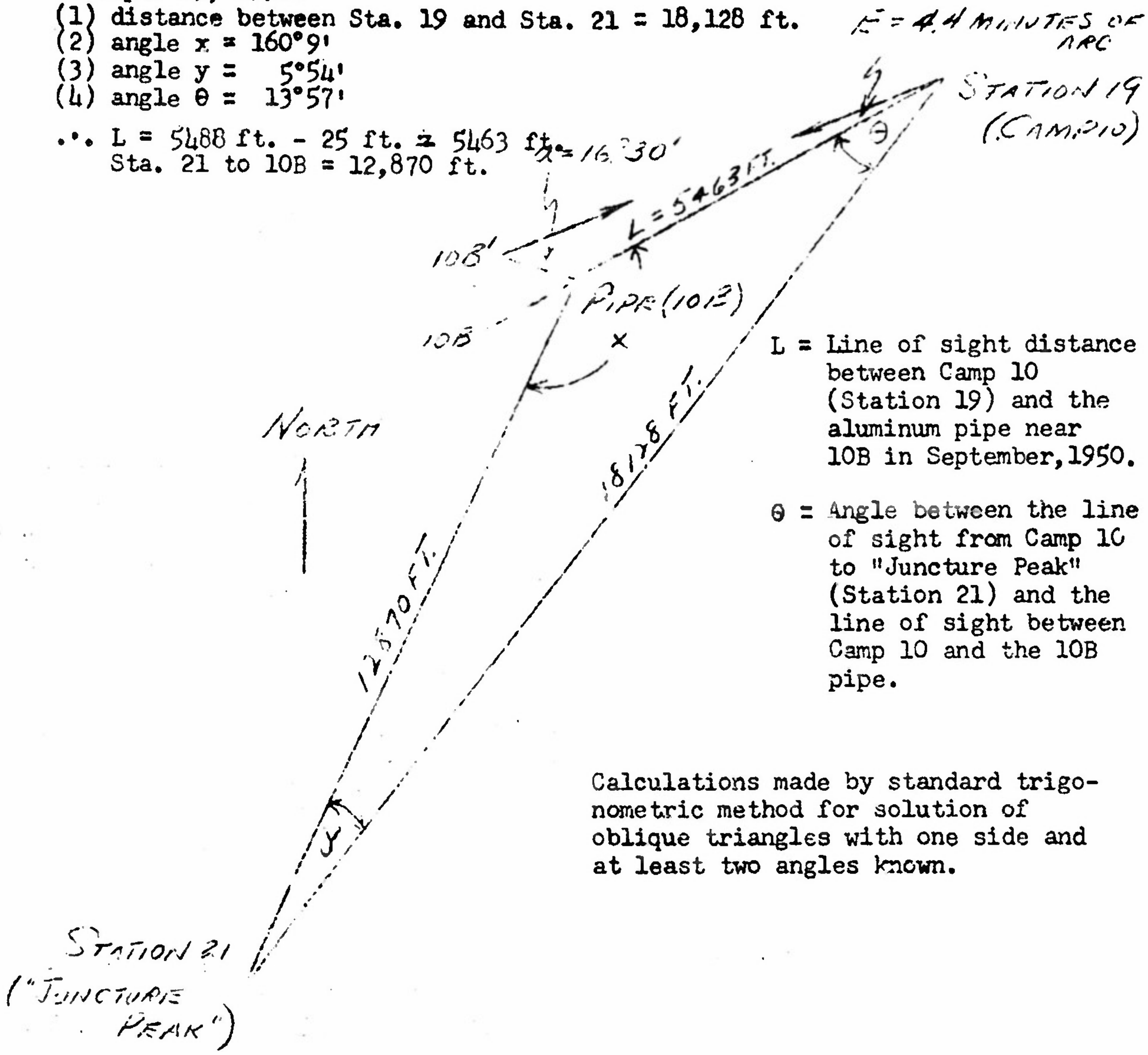
| Date | L | θ | Distance moved in interval noted | Rate of movement in interval noted |
|---|---|---|---|---|
| 15 Sept. '50 | 5463 ft. | 13°57.0' | 266 ft. (265.5') | 1.86 ft./day |
| 6 Feb . '51 | 5463 ft. | 11° 9.9' | | |
| 20 Feb . '51 | 5463 ft. | 10°49.7' | 32 ft. ( 32.1') | 2.3 ft./day |
| 26 Feb , '51 | 5463 ft. | 10°43.5' | 10 ft. ( 9.9') | 1.65 ft./day |

Average, Feb. Period = 2.1 ft./day

Given: from previous survey on Sept. 15, 1950:

(1) distance between Sta. 19 and Sta. 21 = 18,128 ft.
(2) angle x = 160°9'
(3) angle y = 5°54'
(4) angle θ = 13°57'

.'. L = 5488 ft. - 25 ft. = 5463 ft.
Sta. 21 to 10B = 12,870 ft.




L = Line of sight distance between Camp 10 (Station 19) and the aluminum pipe near 10B in September, 1950.

θ = Angle between the line of sight from Camp 10 to "Juncture Peak" (Station 21) and the line of sight between Camp 10 and the 10B pipe.

Calculations made by standard trigonometric method for solution of oblique triangles with one side and at least two angles known.

5. Vertical Velocity Distribution Profile at Drill Site

As a continuation of the previous summer's englacial investigations, considerable effort was put forth in mid-February to determine the inclination of the 245-foot length of two inch (inside diameter) aluminum pipe which had been implanted vertically into the firn and ice at Camp 10B in August 1950.[39] To effect a re-survey of the alignment of this pipe under the sub-zero conditions encountered required much care. The survey was successfully accomplished, however, and two complete profiles were obtained at an interval of six days. Thus, one served as a good check on the other and the two together provided a useful composite record. A single-shot azimuth-inclinometer was employed at the end of a 250-foot wire cable which was lowered from the surface into the pipe. This instrument was loaned by the Eastman Oil Well Survey Company of Denver, Colorado, which company also very kindly has helped in the plotting of results. A survey of the deformation of the pipe was obtained at 10 to 20-foot intervals by means of a specially designed camera with a shutter feature pre-set by a clock mechanism also contained within the barrel of the instrument. The tabulated records are given together in Appendices K and L for comparison with the record of the previous summer's survey.

The interpretation of the record from these and subsequent surveys is currently in manuscript for another report of this project. This report provides details of the field techniques employed, both in the periodic surveys of the pipe and in its initial installation. It also discusses significance of the deformation, the tilt and the relative displacement of the pipe in terms of those influences which are causing the glacier to flow. As already mentioned, the surface position of the top of the pipe has, at successive intervals, been determined by triangulation.

## V. SUMMARY OF PROGRAM AND RELATIONSHIP TO OTHER SEASONS OF FIELD WORK

The foregoing notes and comments have been presented with the primary purpose of providing continuity and integration to the appended meteorological and glaciological records and to the other observations obtained during this winter expedition to the Juneau Ice Field. It is regretted that more time and funds were not available to allow at least three members of the project to continue to maintain the basic research program at the central station through March, April and May so as to close the gap between the January-February period and that which concerned the subsequent field party from late May until September, 1951. It is hoped that a longer period of observation extending through at least two full and consecutive seasons may eventually be placed in effect. Ideally the research station at Camp 10 should be maintained throughout an entire year of the Taku Glacier's regime, with periodic observations being made at Camp 10B and adjacent sites.

[39] For a brief description of the purpose and procedures involved in the installation of this pipe see "Englacial Investigations Related to Core Drilling on the Upper Taku Glacier", Journal of Glaciology, Vol. 1, No. 10, 1951, pp. 578-80

Although the information obtained on this winter expedition is lacking in certain details, it is possible to draw conclusions concerning the character and relative budgetary influence of winter climate and of thermal and structural changes in the Taku Glacier at this season. The facts and data presented, when fully analyzed and coordinated with similar records from the more temperate months at the glacier sites, will provide much more useful interpretations than would be possible by a review of these data alone.

In any future program, a more concentrated and extensive time-profile record of the highland snow pack should be planned. Such a study could be based on some of the procedures and techniques employed here and which have been carried to such a fine degree of precision at the Swiss Federal Institute for Snow and Avalanche Research on the Weissfluhjoch at Davos, Switzerland. For these lines of field research the winter season on the Juneau Ice Field is well suited.

# VI. APPENDICES

W. B. Form 1001-C

# APPENDIX A (1)

## U. S. DEPARTMENT OF COMMERCE, WEATHER BUREAU

## STATION METEOROLOGICAL SUMMARY

STATION Camp 10 - 3862 feet MONTH Jan. 27 - Feb. 26 YEAR 1951

120th STANDARD TIME

| Date | Day (1) | Temp. °F Maximum (2) | Minimum (3) | Average (4) | Departure from normal (5) | Degree days (base 65°) (6) | Precip. Total (water equivalent)[1] (7) | Snowfall, sleet, hail[2] (8) | Snow, sleet & hail on ground at (9) | Wind[3] Prevailing direction (10) | Average speed (m.p.h.) (11) | Fastest mile Speed (m.p.h.) (12) | Fastest mile Direction (13) | Sunshine Total (hours and minutes) (14) | Percent of possible (15) | Sky cover[3] Sunrise to sunset (tenths) (16) | Midnight to midnight (tenths) (17) | Thunderstorm or distant lightning (18) | Visibility 1/2 mi. or less caused by (19) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 27 | x | 13 | 5 | 9 | | 56 | 0.00 | 0.0 | 240 | W | 3.1 | 8 | W | 3:45 | 47 | 0 | | | -- |
| 28 | x | 18 | 4 | 11 | | 54 | 0.00 | 0.0 | 240 | NW | 0.2 | 1 | NW | 5:15 | 64 | 5 | | | -- |
| Jan. 29 | x | 15 | 7 | 11 | | 54 | 0.00 | 0.0 | 240 | W | 2.1 | 8 | W | 3:00 | 38 | 7 | | | -- |
| 30 | x | 18 | 5 | 12 | | 53 | 0.00 | 0.0 | 240 | NW | 2.0 | 7 | NE | -- | -- | 10 | | | -- |
| 31 | x | 19 | 11 | 15 | | 50 | 0.30 | 3.0 | 242 | E | 2.9 | 9 | E | -- | -- | 10 | | | -- |
| 1 | x | 23 | 10 | 17 | | 48 | 0.02 | 0.2 | 242 | NE | 4.4 | -- | -- | -- | -- | 8 | | | -- |
| 2 | x | 13 | 4 | 9 | | 56 | 0.00 | 0.0 | 242 | E | 20.5 | 40* | E | -- | -- | 5 | | | -- |
| 3 | x | 4 | -10 | -3 | | 68 | 0.00 | 0.0 | 242 | N | 3.5 | -- | -- | -- | -- | 8 | | | -- |
| 4 | x | -3 | -10 | -7 | | 72 | 0.00 | 0.0 | 242 | NNE | 9.1 | 14 | E | 6:00 | 72 | 6 | | | -- |
| 5 | x | 7 | -11 | -2 | | 67 | 0.00 | 0.0 | 242 | W | 2.3 | 9 | NNE | 6:25 | 75 | 0 | | | -- |
| 6 | x | 5 | -3 | 1 | | 64 | 0.00 | 0.0 | 242 | N | 1.4 | -- | -- | -- | -- | 0 | | | -- |
| 7 | x | 9 | -5 | 2 | | 63 | 0.11 | 1.1 | 243 | W | 5.6 | -- | -- | -- | -- | 10 | | | S |
| 8 | x | 2 | -3 | -1 | | 66 | 0.40 | 4.0 | 247 | W-E | 0.3 | -- | -- | -- | -- | 10 | | | -- |
| 9 | x | 8 | -4 | 2 | | 63 | T | T | 247 | E | 0.5 | -- | -- | 6:15 | 70 | 0 | | | -- |
| 10 | x | 12 | -3 | 5 | | 60 | 0.00 | 0.0 | 247 | N | 1.2 | -- | -- | 6:10 | 66 | 1 | | | -- |
| 11 | x | 25 | 11 | 18 | | 47 | 0.00 | 0.0 | 247 | NE | 0.8 | 3 | NE | 6:30 | 72 | 5 | | | -- |
| 12 | x | 24 | 11 | 18 | | 47 | 0.00 | 0.0 | M | W | 2.0 | -- | -- | 5:00 | 55 | 10 | | | -- |
| Feb. 13 | x | 21 | 12 | 17 | | 48 | 0.25 | 5.0 | M | W | 6.4 | -- | -- | -- | -- | 10 | | | -- |
| 14 | x | 24 | 18 | 21 | | 44 | 0.61 | 10.0 | M | NW | 2.3 | -- | -- | -- | -- | 10 | | | -- |
| 15 | x | 25 | 22 | 24 | | 41 | 0.90 | 9.0 | M | ESE | 21.6 | -- | -- | -- | -- | 10 | | | S,BS |
| 16 | x | 25 | 22 | 24 | | 41 | 0.55 | 5.5 | M | SE | 21.9 | -- | -- | -- | -- | 10 | | | S,BS |
| 17 | x | 24 | 18 | 21 | | 44 | 0.08 | 0.8 | M | NE | 1.4 | 4 | N | -- | -- | 8 | | | -- |
| 18 | x | 23 | 19 | 21 | | 44 | 0.13 | 13.0 | M | SE | 23.1 | 28* | SE | -- | -- | 10 | | | S,BS |
| 19 | x | 24 | 19 | 22 | | 43 | 0.16 | 1.6 | M | E | 2.3 | 15 | E | -- | -- | 9 | | | -- |
| 20 | x | 24 | 13 | 19 | | 46 | T | T | M | E | 1.5 | -- | -- | 2:45 | 28 | 6 | | | F |
| 21 | x | 23 | 14 | 19 | | 46 | 0.05 | 0.5 | M | SE | 13.7 | -- | -- | -- | -- | 8 | | | F,S,BS,BD |
| 22 | x | 23 | 20 | 22 | | 43 | 0.33 | 3.3 | M | SE | 21.1 | -- | -- | -- | -- | 10 | | | F,S,BS |
| 23 | x | 22 | 17 | 20 | | 45 | 0.21 | 2.1 | M | SE | 12.7 | -- | -- | -- | -- | 10 | | | -- |
| 24 | x | 20 | 12 | 16 | | 49 | 0.05 | 0.5 | M | NE | 19.4 | -- | -- | -- | -- | 10 | | | -- |
| 25 | x | 13 | 2 | 8 | | 57 | 0.01 | 0.1 | M | [illegible] | 12.4 | -- | -- | -- | -- | 5 | | | -- |
| 26 | x | -- | -- | -- | | -- | .30 | T | -- | -- | -- | -- | -- | -- | -- | -- | | | -- |
| Sum | | 503 | 227 | | | | | | | | 228.7 | | | 51:05 | | 211 | | | |
| Avg. | | 16.8 | 7.6 | | | | | | | | 7.6 | Fastest -- | Direction -- | Possible | % | 7 | | | |
| | | | | | | | | | | W | Max. | | | | | | | | |

TEMPERATURE DATA

AVERAGE MONTHLY 12.4

DEPARTURE FROM NORMAL

HIGHEST 25 ON 11,15,16

LOWEST -11 ON 5

NUMBER OF DAYS WITH—

MAX. 32° OR BELOW 30

MAX. 90° OR ABOVE 0

MIN. 32° OR BELOW 30

MIN. 0° OR BELOW 8

DEGREE DAYS (BASE 65°)— --

TOTAL THIS MONTH --

DEPARTURE FROM NORMAL --

SEASONAL TOTAL --

DEPARTURE FROM NORMAL --

PRECIPITATION DATA

TOTAL FOR THE MONTH 4.16 IN.

DEPARTURE FROM NORMAL IN.

GREATEST IN 24 HOURS 0.90 ON 15

SNOWFALL, SLEET, AND HAIL

TOTAL FOR THE MONTH 48.0 IN.

GREATEST IN 24 HOURS 10.0 ON 14

GREATEST DEPTH ON GROUND ON

BAROMETRIC PRESSURE

MONTHLY AVERAGE STATION -- IN.

HIGHEST SEA-LEVEL -- IN. ON --

LOWEST SEA-LEVEL -- IN. ON --

WEATHER

NUMBER OF DAYS—

CLEAR (Scale 0-3) 5

PARTLY CLOUDY (Scale 4-7) 7

CLOUDY (Scale 8-10) 18

WITH 0.01 INCH OR MORE PRECIP. 16

WITH 0.10 INCH OR MORE PRECIP. 11

WITH 0.50 INCH OR MORE PRECIP. 3

WITH 1.00 INCH OR MORE PRECIP. 0

DATES OF—

HAIL --

SLEET --

GLAZE --

SYMBOLS USED IN COLUMNS 18-19

A—Hail
BS—Blowing Snow
DL—Distant Lightning
D—Dust
E—Sleet
F—Fog
H—Haze
K—Smoke
L—Drizzle
R—Rain
S—Snow
T—Thunderstorm
ZL—Freezing Drizzle
ZR—Freezing Rain

1 10 to 1 ratio of snow to precip. used unless otherwise indicated on 1130A

2 24 hours 2200 - 2200

3 From 0700 to 2200 daily

* Gusts estimated to 70 m.p.h.

W. B. Form 1001-C

# APPENDIX A (2)

## U. S. DEPARTMENT OF COMMERCE, WEATHER BUREAU

## STATION METEOROLOGICAL SUMMARY

STATION Camp 10B - 3600 feet MONTH Feb. 4 - Feb. 26 YEAR 1951

120th STANDARD TIME

| Day (1) | Temp. °F Maximum (2) | Minimum (3) | Average (4) | Departure from normal (5) | Degree days (base 65°) (6) | Precip. Total (water equivalent) (7) | Snowfall, sleet, hail (8) | Snow, sleet & hail on ground at (9) | Wind Prevailing direction (10) | Average speed (m.p.h.) (11) | Fastest mile Speed (m.p.h.) (12) | Fastest mile Direction (13) | Sunshine Total (hours and minutes) (14) | Percent of possible (15) | Sky cover Sunrise to sunset (tenths) (16) | Midnight to midnight (tenths) (17) | Thunderstorm or distant lightning (18) | Visibility 1/2 mi. or less caused by (19) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | | |
| 4 | -- | -30 | -- | | -- | | -- | | -- | -- | -- | -- | (same as Camp 10) | | | | | -- |
| 5 | -- | -28.5 | -- | | -- | | -- | | -- | -- | -- | -- | | | | | | -- |
| 6 | -- | -21.6 | -- | | -- | | -- | | -- | -- | -- | -- | | | | | | -- |
| 7 | -- | -27 | -- | | -- | | 1.0 | | S | 5.9 | -- | -- | | | | | | -- |
| 8 | -- | -26* | -- | | -- | | 3.0 | | NW | 1.3 | -- | -- | | | | | | -- |
| 9 | -- | -29 | -- | | -- | | -- | | NW | 3.8 | -- | -- | | | | | | -- |
| 10 | -1 | -24 | -13 | | 78 | | -- | | -- | -- | -- | -- | | | | | | -- |
| 11 | 10 | -15 | -3 | | 68 | | -- | | NW | 5.4 | -- | -- | | | | | | -- |
| 12 | 11 | -5 | 3 | | 62 | | -- | | N | 7.5 | -- | -- | | | | | | -- |
| 13 | -- | -- | -- | | -- | | 5.0 | | SE | 1.4 | -- | -- | | | | | | S |
| 14 | -- | -- | -- | | -- | | 20.5 | | SE | 2.0 | -- | -- | | | | | | S |
| 15 | 29 | 20 | 25 | | 40 | | 10.0 | | S | 16.5 | -- | -- | | | | | | S |
| 16 | 26 | 22 | 24 | | 41 | | 15.0 | | SE | 19.7 | | | | | | | | S,SP,BS |
| 17 | 24 | 3 | 14 | | 51 | | 7.0 | | W-N | 2.1 | -- | -- | | | | | | -- |
| 18 | 24 | 22 | 23 | | 42 | | 13.0 | | ESE | 11.9 | -- | -- | | | | | | S |
| 19 | 27 | 5 | 16 | | 49 | | 5.0 | | NW | 1.4 | -- | -- | | | | | | -- |
| 20 | -- | -- | -- | | -- | | -- | | NW | 1.6 | -- | -- | | | | | | -- |
| 21 | 29 | 3* | 16 | | 49 | | -- | | E | 5.7 | -- | -- | | | | | | -- |
| 22 | 24 | 8 | 16 | | 49 | | -- | | SE | 15.6 | -- | -- | | | | | | -- |
| 23 | 27 | 15 | 21 | | 44 | | -- | | SE | 9.6 | -- | -- | | | | | | -- |
| 24 | -- | -- | -- | | -- | | -- | | N | 20.9 | -- | -- | | | | | | S,BS |
| 25 | -- | -- | -- | | -- | | T | | NE | 12.1 | -- | -- | | | | | | -- |
| 26 | -- | -- | -- | | -- | | .3 | | -- | -- | -- | -- | | | | | | -- |
| 27 | | | | | | | | | | | | | | | | | | |
| 28 | | | | | | | | | | | | | | | | | | |
| 29 | | | | | | | | | | | | | | | | | | |
| 30 | | | | | | | | | | | | | | | | | | |
| 31 | | | | | | | | | | | | | | | | | | |
| Sum | | | | | | | | | | | | | | | | | | |
| Avg. | | | | | | | | | | | Fastest | Direction | Possible | % | | | | |

TEMPERATURE DATA

AVERAGE MONTHLY 12°

DEPARTURE FROM NORMAL

HIGHEST 29 ON 15,21

LOWEST -30 ON 4

NUMBER OF DAYS WITH—

MAX. 32° OR BELOW all

MAX. 90° OR ABOVE none

MIN. 32° OR BELOW all

MIN. 0° OR BELOW 8 out of 20

DEGREE DAYS (BASE 65°)—

TOTAL THIS MONTH

DEPARTURE FROM NORMAL

SEASONAL TOTAL

DEPARTURE FROM NORMAL

PRECIPITATION DATA

TOTAL FOR THE MONTH IN.

DEPARTURE FROM NORMAL IN.

GREATEST IN 24 HOURS ON

SNOWFALL, SLEET, AND HAIL

TOTAL FOR THE MONTH IN.

GREATEST IN 24 HOURS ON

GREATEST DEPTH ON GROUND ON

BAROMETRIC PRESSURE

MONTHLY AVERAGE STATION IN.

HIGHEST SEA-LEVEL IN. ON

LOWEST SEA-LEVEL IN. ON

WEATHER

NUMBER OF DAYS—

CLEAR (Scale 0-3)

PARTLY CLOUDY (Scale 4-7)

CLOUDY (Scale 8-10)

WITH 0.01 INCH OR MORE PRECIP.

WITH 0.10 INCH OR MORE PRECIP.

WITH 0.50 INCH OR MORE PRECIP.

WITH 1.00 INCH OR MORE PRECIP.

DATES OF—

HAIL

SLEET

GLAZE

SYMBOLS USED IN COLUMNS 18-19

A—Hail
BS—Blowing Snow
DL—Distant Lightning
D—Dust
E—Sleet
F—Fog
H—Haze
K—Smoke
L—Drizzle
R—Rain
S—Snow
T—Thunderstorm
ZL—Freezing Drizzle
ZR—Freezing Rain

*Minimum temperatures at 10A (on glacier surface 1 mile east of 10B) on these dates were as follows: 5 February, -21.9°F; 8 February, -60°F; 17 February, -12°F; 21 February, -20°F.

# U. S. DEPARTMENT OF COMMERCE, WEATHER BUREAU
## MONTHLY CLIMATOLOGICAL SUMMARY
With Comparative Data

STATION Juneau, Alaska (Airport) MONTH January 1951

Phone 011 : 120 th Meridian Time: Lat. 58 ° 22 'N, Long. 134 ° 35 'W: Elevation 24.00 ft

| DATE | Temp. Maximum | Minimum | Mean | Departure from normal | Degree days base 65° | Precip. Total (inches) | Snowfall (inches) (unmelted) | Depth of snow on the ground | Wind Prevailing direction | Highest velocity | Direction | Percent of possible sunshine | Average cloudiness scale 0 to 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 36 | 26 | 31 | +6 | 34 | 0.03 | T | 1 | E | 14 | E | 0 | 10 |
| 2 | 26 | 18 | 22 | -4 | 43 | 0.00 | 0.0 | 1 | N | 9 | N | 59 | 4 |
| 3 | 25 | 11 | 18 | -8 | 47 | 0.00 | 0.0 | 1 | E | 10 | E | 100 | 8 |
| 4 | 24 | 8 | 16 | -11 | 49 | T | 0.1 | 1 | N | 17 | E | 4 | 9 |
| 5 | 34 | 20 | 27 | -1 | 38 | 0.14 | T | 1 | ESE | 23 | SE | 0 | 10 |
| 6 | 40 | 33 | 37 | +9 | 28 | 0.54 | T | 1 | SSE | 28 | SE | 0 | 10 |
| 7 | 39 | 32 | 36 | +7 | 29 | 0.37 | 0.0 | T | SE | 29 | SE | 0 | 10 |
| 8 | 36 | 33 | 35 | +5 | 30 | 0.16 | T | T | SE | 30 | SE | 0 | 10 |
| 9 | 33 | 29 | 31 | +1 | 34 | 0.25 | 0.6 | 1 | E | 13 | E | 0 | 10 |
| 10 | 31 | 27 | 29 | 0 | 36 | 0.13 | 1.8 | 2 | N | 9 | S | 0 | 10 |
| 11 | 33 | 25 | 29 | +1 | 36 | 0.07 | 0.8 | 3 | E | 25 | SE | 50 | 10 |
| 12 | 36 | 29 | 33 | +6 | 32 | 0.08 | 0.6 | 2 | SE | 38 | SE | 0 | 10 |
| 13 | 31 | 22 | 27 | +1 | 38 | 0.10 | 2.4 | 5 | ESE | 19 | SW | 0 | 10 |
| 14 | 28 | 23 | 26 | +1 | 39 | 0.16 | 1.8 | 7 | SE | 20 | SE | 0 | 10 |
| 15 | 24 | 6 | 15 | -8 | 49 | 0.01 | 0.2 | 7 | N | 8 | N | 7 | [illegible] |
| 16 | 13 | -1 | 6 | -18 | 59 | 0.00 | 0.0 | 7 | N | 8 | NE | 100 | 0 |
| 17 | 17 | -3 | 7 | -17 | 58 | T | T | 7 | E | 17 | SE | 29 | 0 |
| 18 | 18 | 8 | 13 | -11 | 52 | 0.02 | 0.3 | 7 | E | 17 | SE | 0 | 10 |
| 19 | 12 | -3 | 5 | -19 | 60 | T | T | 7 | N | 8 | N | 30 | 9 |
| 20 | 25 | 11 | 18 | -6 | 47 | T | T | 7 | N | 10 | E | 6 | 10 |
| 21 | 21 | 16 | 19 | -5 | 46 | 0.01 | 0.2 | 7 | N | 8 | NE | 61 | 10 |
| 22 | 16 | 11 | 14 | -10 | 51 | 0.01 | 0.4 | 7 | ESE | 13 | SE | 0 | 10 |
| 23 | 13 | 8 | 11 | -12 | 54 | T | T | 7 | SE | 17 | SE | 0 | 10 |
| 24 | 12 | 8 | 10 | -13 | 55 | 0.01 | 0.1 | 7 | N | 11 | SE | 0 | 10 |
| 25 | 14 | -1 | 7 | -16 | 58 | T | T | 7 | SE | 16 | SE | 42 | 9 |
| 26 | 17 | -3 | 7 | -15 | 58 | 0.00 | 0.0 | 7 | N | 15 | SE | 100 | 0 |
| 27 | 14 | -7 | 4 | -17 | 61 | 0.00 | 0.0 | 7 | N | 0 | N | 100 | 0 |
| 28 | 15 | -8 | 4 | -19 | 61 | 0.00 | 0.0 | 7 | N | 3 | NE | 92 | 4 |
| 29 | 18 | -1 | 9 | -13 | 56 | 0.00 | 0.0 | 7 | NNE | 6 | N | 52 | 8 |
| 30 | 20 | 2 | 11 | -11 | 43 | 0.00 | 0.0 | 6 | N | 6 | N | 0 | 10 |
| 31 | 27 | 19 | 8 | -0 | 42 | T | T | 6 | E | 14 | SE | 0 | 10 |
| Mean | 24.1 | 12.9 | 18.5 | -6.7 | 1423 | 2.09 | 9.5 | | N | 38 | SE | 21 | 8.4 |
| Normal | - | - | 25.2 | | | 4.06 | - | | - | - | - | - | - |

| PRESSURE | Mean | | Highest | | Date | Lowest | | Date |
|---|---|---|---|---|---|---|---|---|
| Station | 29.017 in. | 1009.7 mb | 30.90 in. | 1046.4 mb | 28 | 29.24 in. | 983.4 mb | 12 |
| Sea Level | 29.825 in. | 1010.3 mb | 30.93 in. | 1047.3 mb | 28 | 29.27 in. | 984.3 mb | 12 |

TEMPERATURE.—Mean this month last year 18.5. This month since 1943: warmest 34.8 in 1944; coldest 7.9 in 1950.
Highest 40 date 6; lowest -8 date 28. This month since 1943: highest 48 date 10, 1944; lowest -19 date 1, 1950.
Average daily departure since Jan. 1 -6.7 Degree days: since July 1 5615; normal 5266; since Sept. 1 5049; normal 4593.
Number of days:—Max. 100° or above 0; 90° or above 0; —Min. 32° or below 29; 0° or below 8; —10° or below 0.
Normal number:—Max. 100° or above 0; 90° or above 0; —Min. 32° or below 25; 0° or below 5; —10° or below 1.

PRECIPITATION.—Departure -1.97. Total since Jan. 1 2.09. Dep. -1.97; total since July 1 29.70. Dep. -7.73.
Total this month last year 0.94. This month since 1943: wettest 2.33 in 1949; driest 0.94 in 1950.
Greatest this month in: Greatest this month since 1943 in: SNOWFALL—Total since July 1 54.7 Dep. -
5 min. .. date ..; 5 min. .05 date 7, 1947. Greatest monthly, this month since 1943 35.4 in 1946
10 min. .. date ..; 10 min. .07 date 12-13, 1948. least monthly this month since 1943 9.0 in 1949
15 min. .03 date 9; 15 min. .09 date 12-13, 1948. Greatest in 24 hrs. 2.8 date 13-14
20 min. .. date ..; 20 min. .12 date 12-13, 1948. this month since 1943 8.9 date 2-3, 1950
30 min. .04 date 5; 30 min. .15 date 12-13, 1948. Greatest any single storm 5.0 date 13-15
1 hr. .05 date 9, 5; 1 hr. .25 date 12-13, 1948. this month since 1943 9.8 date 18-21, 1947
2 hr. .09 date 6, 5; 2 hr. .47 date 12-13, 1948. Greatest on ground 7 date 14 to 29
24 hr. .40 date 6-7; 24 hr. 2.71 date 12-13, 1948. this month since 1943 15.9 date 3-14, 1950
Number of days with precipitation: trace 7; 0.01 inch or more 16; 0.25 inch or more 3; 1 inch or more 0; 2 inches or more 0.
Normal number of days with precipitation: trace 5; 0.01 inch or more 20; 0.25 inch or more 5; 1 inch or more ..; 2 inches or more ..
Greatest number of days this month since 1943 with precipitation 0.01 inch or more 26 in 1946; least number 7 in 1950.

CHARACTER OF DAY.—Number of days clear 3; partly cloudy 2; cloudy 26. Normal number clear 5; partly cloudy 2; cloudy 24.
SUNSHINE.—Total hours this month 61.5. Total hours possible on 1st 6.5; on 15th 7.2; on last day 8.2; this month 223.
MISCELLANEOUS PHENOMENA (DATES)—Hail None Sleet None Glaze None
Fog: Light (5/16-6 mi) 9, 10 Heavy (0-1/4 mi) 19
Freeze: Light None Killing None
Thunderstorms None Duststorms None Tornadoes None Hurricanes None

a, City Office. b, Airport. c, Total. d, Monthly. e, Sunrise to sunset: 0 to 3, clear; 4 to 7, partly cloudy; 8 to 10, cloudy. f, other dates. g, Light fog: visibility 6 miles to 1,000 ft.; heavy, 1,000 ft. to 0. T indicates a trace of precipitation.

Claude V. Brown
Official in Charge, Weather Bureau.



# U. S. DEPARTMENT OF COMMERCE, WEATHER BUREAU
## MONTHLY CLIMATOLOGICAL SUMMARY
With Comparative Data

STATION Juneau, Alaska (Airport) MONTH February 1951

Phone 011 : 120 th Meridian Time: Lat. 58 ° 22 'N, Long. 134 ° 35 'W: Elevation 24.00 ft

| DATE | Temp. Maximum | Minimum | Mean | Departure from normal | Degree days base 65° | Precip. Total (inches) | Snowfall (inches) (unmelted) | Depth of snow on the ground | Wind Prevailing direction | Highest velocity | Direction | Percent of possible sunshine | Average cloudiness scale 0 to 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 27 | 12 | 20 | -4 | 45 | 0.00 | 0.0 | 6 | E | 7 | N | 100 | 5 |
| 2 | 27 | 6 | 17 | -9 | 48 | 0.00 | 0.0 | 6 | N | 17 | E | 100 | 1 |
| 3 | 17 | -1 | 8 | -18 | 57 | 0.00 | 0.0 | 5 | SE | 18 | E | 100 | 9 |
| 4 | 17 | 1 | 9 | -18 | 56 | 0.00 | 0.0 | 5 | E | 13 | SE | 54 | 9 |
| 5 | 16 | [illegible] | 6 | -21 | 59 | 0.00 | 0.0 | 5 | N | 17 | SE | 100 | [illegible] |
| 6 | 18 | -8 | 5 | -22 | 60 | 0.00 | 0.0 | 4 | E | 11 | E | 100 | 0 |
| 7 | 21 | -4 | 9 | -18 | 56 | 0.04 | 1.2 | 4 | N | 18 | SE | 8 | 10 |
| 8 | 22 | 8 | 7 | -20 | 58 | 0.06 | 4.3 | 7 | E | 8 | E | 51 | 8 |
| 9 | 21 | -2 | 10 | -17 | 55 | T | T | 7 | N | 7 | N | 100 | 0 |
| 10 | 19 | -8 | 6 | -21 | 59 | 0.00 | 0.0 | 6 | N | 4 | SE | 100 | 0 |
| 11 | 21 | -7 | 7 | -20 | 58 | 0.00 | 0.0 | 6 | N | 5 | N | 100 | 5 |
| 12 | 22 | -5 | 10 | -17 | 55 | 0.00 | 0.0 | 6 | E | 10 | E | 36 | 8 |
| 13 | 30 | 17 | 24 | -3 | 41 | 0.14 | 2.1 | 7 | E | 20 | E | 0 | 10 |
| 14 | 32 | 26 | 29 | +2 | 36 | 0.56 | 6.9 | 12 | E | 3 | E | 0 | 10 |
| 15 | 34 | 32 | 33 | +6 | 32 | 0.38 | 1.2 | 13 | E | 26 | SE | 0 | 10 |
| 16 | 37 | 34 | 36 | +8 | 29 | 0.62 | T | 8 | ESE | 31 | SE | 0 | 10 |
| 17 | 36 | 33 | 35 | +7 | 30 | 0.04 | T | 5 | E | 15 | E | 17 | 10 |
| 18 | 36 | 33 | 35 | +7 | 30 | 0.29 | T | 4 | ESE | 27 | SE | [illegible] | 10 |
| 19 | 36 | 32 | 34 | +6 | 31 | 0.05 | T | 3 | E | 23 | E | 10 | 10 |
| 20 | 35 | 30 | 33 | +5 | 32 | T | T | 2 | NW | 9 | SW | 63 | 9 |
| 21 | 35 | 30 | 33 | +5 | 32 | T | T | 2 | ESE | 22 | SE | [illegible] | 9 |
| 22 | 36 | 32 | 34 | +6 | 31 | 0.05 | 0.1 | 2 | E | 18 | SE | 0 | 10 |
| 23 | 36 | 31 | 34 | +6 | 31 | 0.03 | T | 2 | ESE | 16 | SE | 4 | 10 |
| 24 | 37 | 25 | 31 | +3 | 34 | 0.00 | 0.0 | 1 | N | 8 | N | 48 | 10 |
| 25 | 30 | 15 | 23 | -6 | 42 | 0.00 | 0.0 | 1 | N | 17 | E | 32 | [illegible] |
| 26 | 28 | 10 | 19 | -10 | 46 | T | T | 1 | E | 19 | E | 9 | 10 |
| 27 | 32 | 26 | 29 | 0 | 36 | 0.07 | 3.0 | 2 | ESE | 18 | SE | [illegible] | 10 |
| 28 | 33 | 19 | 26 | -4 | 39 | 0.04 | 1.2 | 4 | E | 15 | E | 60 | 8 |
| 29 | | | | | | | | | | | | | |
| 30 | | | | | | | | | | | | | |
| 31 | | | | | | | | | | | | | |
| Mean | 28.3 | 14.8 | 21.6 | -5.9 | 1218 | 2.31 | 20.0 | | E | 31 | SE | 41 | 7.4 |
| Normal | - | - | 27.5 | | 1051 | 4.20 | - | | - | - | - | - | - |

| PRESSURE | Mean | | Highest | | Date | Lowest | | Date |
|---|---|---|---|---|---|---|---|---|
| Station | 29.871 in. | 1011.5 mb | 30.42 in. | 1030.1 mb | 21 | 29.12 in. | 956.1 mb | 16 |
| Sea Level | 29.898 in. | 1012.4 mb | 30.447 in. | 1031.0 mb | 21 | 29.147 in. | 987.0 mb | 16 |

TEMPERATURE.—Mean this month last year 23.4. This month since 1944: warmest 31.6 in 1946; coldest 16.2 in 1949.
Highest 37 date 16f; lowest -8 date 6f. This month since 1944: highest 46 date 28, 1947; lowest -12 date 20, 1949.
Average daily departure since Jan. 1 -12.6 Degree days: since July 1 6863; normal 6317; since Sept. 1 6257; normal 5644.
Number of days:—Max. 100° or above 0; 90° or above 0; —Min. 32° or below 25; 0° or below 8; —10° or below 0.
Normal number:—Max. 100° or above 0; 90° or above 0; —Min. 32° or below 24; 0° or below 3; —10° or below 0.

PRECIPITATION.—Departure -1.89. Total since Jan. 1 4.40. Dep. -3.86; total since July 1 32.01. Dep. -9.62.
Total this month last year 2.22. This month since 1944: wettest 4.23 in 1949; driest 1.44 in 1948.
Greatest this month in: Greatest this month since 1944 in: SNOWFALL—Total since July 1 74.7 Dep. -
5 min. .. date ..; 5 min. .03 date 12, 1948. Greatest monthly, this month since 1944 39.6 1949
10 min. .. date ..; 10 min. .04 date 12, 1948. least monthly this month since 1944 6.7 in 1945
15 min. .04 date 16; 15 min. .05 date 25, 1945. Greatest in 24 hrs. 6.9 date 14th
20 min. .. date ..; 20 min. .06 date 25, 1945. this month since 1944 23.7 date 12-13, 1949
30 min. .05 date 16; 30 min. .08 date 25, 1945. Greatest any single storm 10.2 date 13 to 15
1 hr. .09 date 16; 1 hr. .10 date 13, 1949. this month since 1944 25.4 date 12-13, 1949
2 hr. .14 date 16; 2 hr. .20 date 13, 1949. Greatest on ground 15 date 15th
24 hr. .71 date 15-16; 24 hr. 2.37 date 12-13, 1949. this month since 1944 37 date 4, 1947
Number of days with precipitation: trace 4; 0.01 inch or more 13; 0.25 inch or more 3; 1 inch or more 0; 2 inches or more 0.
Normal number of days with precipitation: trace 6; 0.01 inch or more 16; 0.25 inch or more 1; 1 inch or more 0; 2 inches or more 0.
Greatest number of days this month since 1944 with precipitation 0.01 inch or more 24 in 1946; least number 13 in 1948.

CHARACTER OF DAY.—Number of days clear 5; partly cloudy 3; cloudy 20. Normal number clear 4; partly cloudy 3; cloudy 21.
SUNSHINE.—Total hours this month 106.4. Total hours possible on 1st 8.0; on 15th 9.5; on last day 10.5; this month 252.2.
MISCELLANEOUS PHENOMENA (DATES)—Hail None Sleet 15th Glaze None
Fog: Light (5/16-6 mi) 19th Heavy (0-1/4 mi) None
Freeze: Light None (Solar Halo on 12th) (Aurora on 5,6,7,8,11) Killing None
Thunderstorms None Duststorms None Tornadoes None Hurricanes None

a, City Office. b, Airport. c, Total. d, Monthly. e, Sunrise to sunset: 0 to 3, clear; 4 to 7, partly cloudy; 8 to 10, cloudy. f, other dates. g, Light fog: visibility 6 miles to 1,000 ft.; heavy, 1,000 ft. to 0. T indicates a trace of precipitation.

Claude V. Brown
Official in Charge, Weather Bureau.



# U. S. DEPARTMENT OF COMMERCE, WEATHER BUREAU
## MONTHLY CLIMATOLOGICAL SUMMARY
With Comparative Data

STATION Juneau, Alaska (Airport) MONTH March 1951

Phone 011 : 120 th Meridian Time: Lat. 58 ° 22 'N, Long. 134 ° 35 'W: Elevation 24.00 ft

| DATE | Temp. Maximum | Minimum | Mean | Departure from normal | Degree days base 65° | Precip. Total (inches) | Snowfall (inches) (unmelted) | Depth of snow on the ground | Wind Prevailing direction | Highest velocity | Direction | Percent of possible sunshine | Average cloudiness scale 0 to 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 33 | 26 | 30 | -2 | 35 | 0.07 | 1.5 | 4 | E | 14 | E | 21 | 10 |
| 2 | 33 | 20 | 27 | -5 | 38 | 0.30 | 4.8 | 9 | E | 11 | E | 0 | 10 |
| 3 | 24 | 4 | 14 | -18 | 51 | 0.00 | 0.0 | 8 | E | 25 | NE | 71 | 8 |
| 4 | 6 | -2 | 2 | -30 | 63 | T | T | 7 | NE | 25 | NE | 42 | 10 |
| 5 | 12 | -2 | 5 | -27 | 60 | 0.00 | 0.0 | 7 | E | 17 | SE | 94 | [illegible] |
| 6 | 20 | 7 | 14 | -18 | 51 | 0.00 | 0.0 | 5 | E | 25 | E | 69 | 6 |
| 7 | 19 | 9 | 14 | -18 | 51 | 0.00 | 0.0 | 4 | E | 27 | E | 100 | 0 |
| 8 | 21 | 13 | 17 | -15 | 48 | 0.00 | 0.0 | 4 | E | 27 | E | 100 | 4 |
| 9 | 20 | 12 | 16 | -16 | 49 | 0.00 | 0.0 | 4 | E | 27 | E | 100 | 2 |
| 10 | 17 | 5 | 11 | -21 | 54 | 0.00 | 0.0 | 4 | E | 24 | E | 100 | 0 |
| 11 | 23 | 11 | 17 | -15 | 48 | 0.08 | 2.4 | 4 | SSE | 20 | E | 0 | 10 |
| 12 | 34 | 21 | 28 | -4 | 37 | 0.31 | 6.1 | 6 | E | 28 | SE | 53 | 10 |
| 13 | 32 | 24 | 28 | -4 | 37 | 0.01 | 0.1 | 9 | E | 18 | SE | 0 | 10 |
| 14 | 32 | 21 | 27 | -5 | 38 | T | T | 9 | E | 9 | E | 0 | 10 |
| 15 | 33 | 4 | 19 | -13 | 46 | 0.00 | 0.0 | 8 | E | 14 | SE | 96 | 5 |
| 16 | 32 | 1 | 17 | -15 | 48 | 0.15 | 2.1 | 9 | S | 15 | SE | 13 | 10 |
| 17 | 35 | 27 | 31 | -1 | 34 | 0.33 | 0.8 | 9 | E | 17 | E | 0 | 10 |
| 18 | 38 | 34 | 36 | +4 | 29 | 0.68 | T | 4 | ESE | 27 | SE | 0 | 10 |
| 19 | 41 | 35 | 38 | +6 | 27 | 0.17 | 0.0 | 2 | E | 26 | SE | 0 | 10 |
| 20 | 40 | 33 | 37 | +5 | 28 | 0.37 | 0.0 | 1 | E | 17 | SE | 0 | 10 |
| 21 | 35 | 28 | 32 | -1 | 33 | 0.10 | 0.7 | 2 | E | 17 | [illegible] | 25 | 10 |
| 22 | 32 | 26 | 29 | -4 | 36 | 0.01 | 0.3 | 2 | E | 25 | SE | 0 | 10 |
| 23 | 40 | 29 | 35 | +2 | 30 | 0.19 | 0.6 | 2 | E | 25 | SE | 11 | 10 |
| 24 | 36 | 30 | 33 | -1 | 32 | 0.60 | 3.5 | 6 | E | 14 | S | 0 | 10 |
| 25 | 37 | 34 | 36 | +2 | 29 | 0.12 | T | 4 | SE | 34 | SE | 0 | 10 |
| 26 | 37 | 33 | 35 | +1 | 30 | 0.04 | T | 1 | SE | 14 | SE | [illegible] | [illegible] |
| 27 | 37 | 33 | 35 | +1 | 30 | 0.04 | T | T | E | 25 | SE | 0 | 10 |
| 28 | 37 | 32 | 35 | 0 | 30 | 0.17 | T | T | SSE | 18 | SE | 4 | 10 |
| 29 | 44 | 27 | 36 | +1 | 29 | T | T | T | ESE | 11 | SE | 71 | 6 |
| 30 | 42 | 32 | 37 | +2 | 28 | T | T | T | SE | 20 | SE | 25 | 10 |
| 31 | 46 | 35 | 41 | +5 | 24 | 0.01 | 0.0 | T | SSE | 19 | S | 31 | [illegible] |
| Mean | 31.2 | 20.8 | 26.0 | -6.8 | 1203 | 3.75 | 23.1 | | E | 34 | SE | 31 | [illegible] |
| Normal | - | - | 32.8 | | 999 | 3.05 | - | | - | - | - | - | - |

| PRESSURE | Mean | | Highest | | Date | Lowest | | Date |
|---|---|---|---|---|---|---|---|---|
| Station | 29.937 in. | 1013.7 mb | 30.51 in. | 1033.1 mb | 4 | 29.31 in. | 992.5 mb | 23 |
| Sea Level | 29.963 in. | 1014.6 mb | 30.536 in. | 1034.0 mb | 4 | 29.337 in. | 993.4 mb | 23 |

TEMPERATURE.—Mean this month last year 32.7. This month since 1944: warmest 35.8, 1947; coldest 26.0 in 1951.
Highest 46 date 31; lowest -2 date 4. This month since 1944: highest 49 date 26, 1948; lowest -2 date 4, 1951.
Average daily departure since Jan. 1 -19.4 Degree days: since July 1 8058; normal 7316; since Sept. 1 7462; normal 6643.
Number of days:—Max. 100° or above 0; 90° or above 0; —Min. 32° or below 24; 0° or below 2; —10° or below 0.
Normal number:—Max. 100° or above 0; 90° or above 0; —Min. 32° or below 23; 0° or below 0; —10° or below 0.

PRECIPITATION.—Departure +0.70. Total since Jan. 1 8.15. Dep. -3.16; total since July 1 35.76. Dep. -8.92.
Total this month last year 1.29. This month since 1944: wettest 5.80 in 1947; driest 1.29 in 1950.
Greatest this month in: Greatest this month since 1944 in: SNOWFALL—Total since July 1 97.8 Dep. -
5 min. - date -; 5 min. - date -. Greatest monthly, this month since 1944 52.6 1948
10 min. - date -; 10 min. - date -. least monthly this month since 1944 0.7 1947
15 min. .05 date 12f; 15 min. .08 date 21, 1948. Greatest in 24 hrs. 6.3 date 11-12
20 min. - date -; 20 min. - date -. this month since 1944 31.9 date 20-21, 1948
30 min. .08 date 12; 30 min. .13 date 21, 1948. Greatest any single storm 8.5 date 11-12
1 hr. .12 date 24; 1 hr. .24 date 21, 1948. this month since 1944 32.5 date 20-21, 1948
2 hr. .23 date 24; 2 hr. .44 date 21, 1948. Greatest on ground 10 date 17f
24 hr. .84 date 17-18; 24 hr. 1.81 date 20-21, 1948. this month since 1944 31.2 date 21-22, 1948
Number of days with precipitation: trace 4; 0.01 inch or more 19; 0.25 inch or more 6; 1 inch or more 0; 2 inches or more 0.
Normal number of days with precipitation: trace 5; 0.01 inch or more 19; 0.25 inch or more 5; 1 inch or more 1; 2 inches or more 0.
Greatest number of days this month since 1944 with precipitation 0.01 inch or more 24 in 1946; least number 13 in 1950.

CHARACTER OF DAY.—Number of days clear 3; partly cloudy 3; cloudy 25. Normal number clear 4; partly cloudy 3; cloudy 24.
SUNSHINE.—Total hours this month 112.8. Total hours possible on 1st 10.2; on 15th 11.9; on last day 13.1; this month 357.
MISCELLANEOUS PHENOMENA (DATES)—Hail None Sleet None Glaze None
Fog: Light (5/16-6 mi) 19, 20 Heavy None
Frost: Light None Heavy None Killing None
Thunderstorms None Duststorms None Tornadoes None Hurricanes None

a, City Office. b, Airport. c, Total. d, Monthly. e, Sunrise to sunset: 0 to 3, clear; 4 to 7, partly cloudy; 8 to 10, cloudy. f, other dates. g, Light fog: visibility 6 miles to 1,000 ft.; heavy, 1,000 ft. to 0. T indicates a trace of precipitation.

Claude V. Brown

Appendix B-1

STATION Juneau, Alaska (Airport) MONTH January 1951

PSYCHROMETRIC DATA taken at twenty minutes past the hour

| Date | 0430 PST Dry | Wet | Dew Pt. | Rel. Hum. | 1030 PST Dry | Wet | Dew Pt. | Rel. Hum. | 1630 PST Dry | Wet | Dew Pt. | Rel. Hum. | 2230 PST Dry | Wet | Dew Pt. | Rel. Hum. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 34 | [illegible] | [illegible] | 91 | [illegible] | 32 | 31 | 92 | 22 | 22 | 21 | 95 | 29 | 28 | 27 | 91 |
| 2 | 23 | [illegible] | 20 | 90 | 23 | 22 | 19 | 85 | 24 | 24 | 22 | 91 | 20 | 19 | 14 | 79 |
| 3 | 25 | 21 | 11 | 54 | 14 | 14 | 12 | 92 | 17 | 16 | 12 | 81 | 14 | 13 | 9 | 80 |
| 4 | 12 | 12 | 9 | 86 | 11 | 10 | 5 | 76 | 20 | 19 | 14 | 78 | 22 | 21 | 16 | 76 |
| 5 | 24 | 22 | 15 | 68 | 28 | 27 | 23 | 84 | 33 | 32 | 30 | 87 | 34 | 33 | 32 | 92 |
| 6 | 36 | 35 | 33 | 90 | 38 | 36 | 34 | 87 | 39 | 38 | 36 | 87 | 40 | 38 | 35 | 88 |
| 7 | 38 | 36 | 35 | 68 | 36 | 35 | 34 | 91 | 36 | 36 | 35 | 94 | 32 | 32 | 31 | 95 |
| 8 | 35 | 34 | 32 | 87 | 36* | 35 | 33 | 87 | 35 | 34 | 33 | 92 | 34 | 33 | 32 | 92 |
| 9 | 33 | 33 | 32 | 95 | 32 | 32 | 32 | 97 | 32 | 32 | 31 | 97 | 30 | 30 | 29 | 96 |
| 10 | 30 | 30 | 29 | 97 | 30 | 30 | 29 | 97 | 29 | 29 | 27 | 93 | 29 | 29 | 28 | 96 |
| 11 | 30 | 29 | [illegible] | 91 | 30 | 30 | 29 | 96 | 32 | 30 | 28 | 85 | 33 | 31 | 28 | 90 |
| 12 | 30 | 30 | 29 | 96 | 34 | 33 | 32 | 94 | 34 | 32 | 30 | 85 | 30 | 28 | 22 | 72 |
| 13 | 29 | 26 | 19 | 65 | 27 | 26 | [illegible] | 83 | 27 | 25 | 21 | 78 | 26 | 24 | 19 | 75 |
| 14 | 26 | 25 | 23 | 88 | 25 | 23 | 18 | 72 | 26 | 25 | 22 | 83 | 25 | 23 | 17 | 72 |
| 15 | 21 | 20 | 17 | 85 | 17 | 16 | 12 | 82 | 16 | 16 | 12 | 81 | 9 | 9 | 5 | 83 |
| 16 | 7 | 7 | 2 | 79 | 1 | 1 | -3 | 82 | 12 | 11 | 5 | 71 | 1 | 0 | -6 | 71 |
| 17 | 2 | 1 | -9 | 59 | 8 | 7 | -2 | 63 | 15 | 12 | 0 | 51 | 16 | 14 | 7 | 67 |
| 18 | 17 | 15 | 9 | 69 | 17 | 16 | 8 | 66 | 17 | 15 | 6 | 63 | 13 | 12 | 4 | 66 |
| 19 | 5 | 5 | 0 | 79 | -1 | -1 | -6 | 81 | 11 | 10 | 2 | 68 | 10 | 9 | 3 | 71 |
| 20 | 13 | 12 | 4 | 66 | 18 | 17 | 12 | 79 | 21 | 20 | 15 | 77 | 21 | 20 | 15 | 77 |
| 21 | 20 | 19 | 15 | 80 | 19 | 17 | 11 | 70 | 19 | 17 | 11 | 70 | 16 | 15 | 8 | 70 |
| 22 | 15 | 14 | 10 | 80 | 15 | 14 | 9 | 64 | 14 | 13 | 5 | 66 | 12 | 11 | 2 | 64 |
| 23 | 12 | 11 | 6 | 77 | 12 | 11 | 4 | 71 | 12 | 10 | -1 | 55 | 10 | 9 | -1 | 61 |
| 24 | 9 | 8 | 2 | 76 | 10 | 9 | 2 | 69 | 11 | 10 | 2 | 67 | 11 | 9 | -1 | 58 |
| 25 | 10 | 8 | -3 | 54 | 10 | 9 | 2 | 71 | 12 | 10 | -2 | [illegible] | 2 | 1 | -6 | 69 |
| 26 | 0 | 0 | -7 | 70 | 4 | 4 | -4 | 67 | 15 | 13 | -2 | 46 | 6 | 6 | 0 | 74 |
| 27 | -4 | -4 | -11 | 70 | -4 | -4 | -11 | 69 | 11 | 10 | 4 | 74 | -3 | -3 | -8 | 77 |
| 28 | -6 | -6 | -14 | 67 | -5 | -6 | -15 | 71 | 10 | 9 | 4 | 79 | 0 | -1 | -8 | 72 |
| 29 | 5 | 4 | -3 | 72 | 7 | 7 | 3 | 83 | 14 | 14 | 10 | 84 | 5 | 5 | 0 | 80 |
| 30 | 6 | 5 | -4 | 64 | 7 | 6 | 1 | 72 | 16 | 15 | 11 | 81 | 18 | 17 | 13 | 81 |
| 31 | 27 | 25 | 20 | 77 | 24 | 23 | 20 | 83 | 27 | 26 | 22 | 82 | 22 | 21 | 18 | 88 |
| MEAN | 18.2 | 17.2 | 12.3 | 78 | 17.9 | 17.1 | 12.9 | 81 | 21.6 | 20.5 | 15.4 | 77 | 18.3 | 17.3 | 12.[illegible] | 78 |
| Normal | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

WIND—Number of hours this month below 10 mi. ........ ; 10 mi. and over ........ ; 15 mi. and over ........ ; 20 mi. and over ........ ; 25 mi. and over ........ ; 32 mi. and over ........ ; 40 mi. and over ........

| This Month—Dir. | N | NE | E | SE | S | SW | W | NW | DI | Month |
|---|---|---|---|---|---|---|---|---|---|---|
| Aver. Hrly. Vel. | | | | | | | | | | |
| Percent of Time | | | | | | | | | | |

Maximum velocity this month since ........ miles from ........ on ........ in ........

CEILING AND VISIBILITY FREQUENCIES (Based on hourly record observations) at ........

| Visibility (miles) | Ceiling (feet) 0 | 100-200 | 300-400 | 500-900 | 1000-1900 | 2000-2500 | 3000-4900 | 5000-9500 | Over 9500 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 to 1/4 | | | | | | | | | | |
| 1/4 to 1/2 | | | 1 | [illegible] | 1 | | | | | 6 |
| 1/2 to 3/4 | | | | 3 | [illegible] | 1 | | 1 | 2 | 9 |
| 1 to 2 1/2 | | | 1 | | [illegible] | 3 | 3 | | | 14 |
| 3 to 6 | | | | 1 | 22 | 32 | 44 | | | 99 |
| 7 to 15 | | | | | 4 | 15 | 150 | 69 | 27 | 265 |
| 20 to 30 | | | | | 3 | 1 | 30 | 67 | 250 | 351 |
| 35 or more | | | | | | | | | | |
| Total | | | 2 | 8 | 39 | 52 | 227 | 137 | 279 | 744 |

Frequencies for larger classes can be derived by addition, i.e., "Under 500 feet" from sum of 0, 100-200 and 300-400 classes; "7 miles or more" from sum of classes 7 to 35 miles or more inclusive.

FROST DATA—Average date of last killing frost in spring May 1; first in autumn October 2
Latest date of last killing frost in spring May 10, 1944; earliest in autumn August 25, 1948
Average growing season 152 days; longest 173 days in 1946; shortest 108 days in 1948

GENERAL SUMMARY— The temperature was lower than normal and there was less precipitation than is normally expected. The first half of the month was above normal in temperature and most of the precipitation occurred during that period.

Subscription Price: 50 cents per year including annual summary. Separate copies monthly 5 cents each, annuals 10 cents each. Checks and money orders should be made payable to the Treasurer of the United States. Correspondence regarding subscription should be addressed to the Weather Bureau Airport Station in the city for which this summary was issued.

Appendix B-2

STATION Juneau, Alaska (Airport) MONTH February 1951

PSYCHROMETRIC DATA taken at twenty minutes past the hour

| Date | 0430 PST Dry | Wet | Dew Pt. | Rel. Hum. | 1030 PST Dry | Wet | Dew Pt. | Rel. Hum. | 1630 PST Dry | Wet | Dew Pt. | Rel. Hum. | 2230 PST Dry | Wet | Dew Pt. | Rel. Hum. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 22 | 22 | 19 | 88 | 16 | 16 | 13 | 86 | 26 | 25 | 21 | 82 | 14 | 13 | 8 | 77 |
| 2 | [illegible] | 17 | 13 | 82 | 10 | 10 | 6 | 83 | 25 | 22 | [illegible] | 57 | 8 | 8 | 2 | 76 |
| 3 | 2 | 2 | -2 | 83 | 4 | 3 | -7 | 60 | 14 | 12 | [illegible] | 50 | 10 | 8 | -1 | 61 |
| 4 | 11 | 10 | 2 | 67 | 13 | 11 | -2 | 51 | 14 | 12 | -1 | 51 | 3 | 2 | -4 | 73 |
| 5 | 0 | -0 | -7 | 73 | 3 | 2 | -8 | 60 | 11 | 11 | -6 | 40 | 1 | 0 | -3 | 74 |
| 6 | -5 | -6 | -13 | 67 | -5 | -6 | -18 | 54 | 16 | 13 | -3 | 42 | 2 | 1 | -3 | 77 |
| 7 | 2 | 1 | -6 | 72 | 12 | 10 | 1 | 62 | 20 | 18 | 13 | 76 | 18 | 16 | 8 | 60 |
| 8 | 17 | 17 | 13 | 83 | 13 | 12 | 7 | 78 | 18 | 16 | 7 | 63 | 16 | 16 | 11 | 78 |
| 9 | 10 | 10 | 5 | 79 | 5 | 4 | -3 | 68 | 18 | 17 | 11 | 73 | 1 | 0 | -3 | 68 |
| 10 | -4 | -5 | -13 | 66 | -4 | -5 | -14 | 62 | 16 | 15 | 10 | 76 | -1 | -1 | -4 | 81 |
| 11 | -5 | -5 | -12 | 72 | -1 | -2 | -14 | 53 | 18 | 17 | 12 | 78 | 5 | 5 | 1 | 86 |
| 12 | -2 | -2 | -7 | 80 | 4 | 4 | -2 | 76 | 22 | 20 | 15 | 75 | 17 | 17 | 13 | 85 |
| 13 | 26 | 24 | 18 | 73 | 28 | 27 | 23 | 81 | 29 | 29 | 27 | 92 | 28 | 27 | 25 | 90 |
| 14 | 27 | 27 | 25 | 91 | 28 | 28 | 27 | 95 | 32 | 31 | 29 | 90 | 31 | 31 | 29 | 92 |
| 15 | 31 | 31 | 30 | 95 | 33 | 32 | 31 | 93 | 36 | 35 | 34 | 90 | 35 | 34 | 33 | 92 |
| 16 | 34 | 33 | 32 | 93 | 35 | 34 | 33 | 90 | 36 | 35 | 33 | 91 | 34 | 33 | 32 | 95 |
| 17 | 34 | 33 | 32 | 92 | 35 | 34 | 33 | 90 | 36 | 35 | 33 | 90 | 35 | 34 | 33 | 91 |
| 18 | 35 | 34 | 32 | 91 | 35 | 34 | 31 | 84 | 35 | 34 | 32 | 86 | 35 | 33 | 31 | 89 |
| 19 | 33 | 33 | 32 | 94 | 35 | 34 | 33 | 90 | 35 | 34 | 32 | 90 | 33 | 32 | 32 | 96 |
| 20 | 32 | 30 | 27 | 82 | 32 | 30 | 27 | 81 | 35 | 32 | 27 | 73 | 31 | 30 | 29 | 93 |
| 21 | 31 | 30 | 29 | 94 | 34 | 32 | 29 | 81 | 35 | [illegible] | 27 | 73 | 33 | 32 | 30 | 90 |
| 22 | 35 | 34 | 32 | 87 | 35 | 33 | 30 | 83 | 35 | [illegible] | 31 | 85 | 34 | 33 | [illegible] | 90 |
| 23 | 34 | 33 | 31 | 90 | 35 | 34 | 32 | 89 | 35 | 34 | [illegible] | 88 | 32 | 31 | 30 | 93 |
| 24 | 34 | 30 | 22 | 62 | 33 | 30 | 24 | 69 | 34 | 29 | [illegible] | 49 | 27 | 24 | 15 | 61 |
| 25 | 20 | 19 | 15 | 81 | 23 | 22 | 18 | 80 | 29 | 23 | [illegible] | 38 | 19 | 18 | 11 | 70 |
| 26 | 11 | 11 | 8 | 86 | 18 | 17 | 12 | 76 | 27 | [illegible] | [illegible] | [illegible] | 27 | 24 | 17 | 66 |
| 27 | 27 | 27 | 22 | 72 | 30 | 29 | 27 | 88 | 31 | 30 | [illegible] | [illegible] | 30 | 29 | 27 | 88 |
| 28 | 26 | 27 | 25 | 88 | 26 | 25 | 22 | 85 | 31 | 29 | [illegible] | [illegible] | [illegible] | 23 | 24 | 80 |
| 29 | | | | | | | | | | | | | | | | |
| 30 | | | | | | | | | | | | | | | | |
| 31 | | | | | | | | | | | | | | | | |
| MEAN | 19.3 | 18.5 | 14.4 | 82 | 20.2 | 19.1 | 14.0 | 77 | 26.9 | 24.9 | 18.5 | 72 | 21.2 | 19.9 | 14.0 | 81 |
| Normal | | | | | | | | | | | | | | | | |

WIND—Number of hours this month below 10 mi. ........ ; 10 mi. and over ........ ; 15 mi. and over ........ ; 20 mi. and over ........ ; 25 mi. and over ........ ; 32 mi. and over ........ ; 40 mi. and over ........

| This Month—Dir. | N | NE | E | SE | S | SW | W | NW | DI | Month |
|---|---|---|---|---|---|---|---|---|---|---|
| Aver. Hrly. Vel. | | | | | | | | | | |
| Percent of Time | | | | | | | | | | |

Maximum velocity this month since ........ miles from ........ on ........ in ........

CEILING AND VISIBILITY FREQUENCIES (Based on hourly record observations) at ........

| Visibility (miles) | Ceiling (feet) 0 | 100-200 | 300-400 | 500-900 | 1000-1900 | 2000-2900 | 3000-4900 | 5000-9500 | Over 9500 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 to 1/4 | | | | | | | | | | |
| 1/4 to 1/2 | | | | | | | | | | |
| 1/2 to 3/4 | | | | 3 | | | | | | 3 |
| 1 to 2 1/2 | | | | 10 | 27 | 1 | | | | 38 |
| 3 to 6 | | | 1 | 1 | 22 | 25 | 22 | 1 | 1 | 73 |
| 7 to 15 | | | | 1 | 25 | 38 | 65 | 12 | [illegible] | 190 |
| 20 to 30 | | | | | | 2 | 36 | 66 | 270 | 368 |
| 35 or more | | | | | | | | | | |
| Total | | | 1 | 15 | 74 | 66 | 137 | 86 | 293 | 672 |

Frequencies for larger classes can be derived by addition, i.e., "Under 500 feet" from sum of 0, 100-200 and 300-400 classes; "7 miles or more" from sum of classes 7 to 35 miles or more inclusive.

FROST DATA—Average date of last killing frost in spring May 4; first in autumn September 28
Latest date of last killing frost in spring May 11, 1950; earliest in autumn August 28, 1948
Average growing season 147 days; longest 175 days in 1947; shortest 108 days in 1948

GENERAL SUMMARY— The month of February was drier and cooler than normal with more sunshine than is usually expected. This is the second consecutive month this condition was experienced. The wettest and warmest period was from the 13th to the 21st during which much of the accumulated snow melted.

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Appendix B-3

STATION Juneau, Alaska (Airport) MONTH March 1951

PSYCHROMETRIC DATA taken at twenty minutes past the hour

| Date | 0430 PST Dry | Wet | Dew Pt. | Rel. Hum. | 1030 PST Dry | Wet | Dew Pt. | Rel. Hum. | 1630 PST Dry | Wet | Dew Pt. | Rel. Hum. | 2230 PST Dry | Wet | Dew Pt. | Rel. Hum. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 29 | 28 | 26 | 87 | 29 | 27 | 25 | 80 | 32 | 30 | 28 | [illegible] | 31 | 29 | 25 | 82 |
| 2 | 32 | 30 | 27 | 83 | 32 | 32 | 31 | 93 | 32 | 32 | 31 | 96 | 25 | 25 | 23 | 81 |
| 3 | 12 | 11 | 5 | 71 | 17 | 13 | -8 | 32 | 15 | 12 | -8 | 34 | 8 | 6 | [illegible] | 35 |
| 4 | 4 | 2 | -16 | 36 | 0 | -2 | -18 | 41 | 3 | 1 | -19 | 34 | 1 | 0 | [illegible] | [illegible] |
| 5 | 2 | 1 | -15 | 44 | 5 | 3 | -14 | 39 | 10 | 7 | -13 | 33 | 9 | 7 | -7 | [illegible] |
| 6 | 11 | 6 | -14 | 31 | 15 | 12 | -11 | 28 | 19 | 15 | -5 | 25 | [illegible] | [illegible] | -5 | [illegible] |
| 7 | 14 | 11 | -9 | 34 | 15 | 12 | -4 | 42 | 18 | 15 | 2 | [illegible] | [illegible] | 12 | -6 | 34 |
| 8 | 16 | 13 | -7 | 35 | 18 | 14 | -6 | 34 | 20 | 16 | -2 | 38 | [illegible] | 13 | -16 | [illegible] |
| 9 | 15 | 12 | -13 | 27 | 19 | 15 | -2 | 39 | 20 | 16 | -2 | 46 | [illegible] | 12 | -7 | 34 |
| 10 | 14 | 10 | -10 | 34 | 15 | 12 | -4 | 42 | 16 | 13 | -2 | 45 | 14 | 11 | -6 | [illegible] |
| 11 | 15 | 14 | 7 | 72 | 17 | 15 | 10 | 75 | 23 | 21 | 16 | 74 | 22 | 21 | 18 | [illegible] |
| 12 | 24 | 24 | 21 | 89 | 29 | 28 | 25 | 84 | 33 | 31 | 28 | 81 | 30 | 30 | 26 | [illegible] |
| 13 | 27 | 26 | 23 | 84 | 29 | 27 | [illegible] | 79 | 32 | 30 | 27 | 81 | 28 | 27 | [illegible] | 87 |
| 14 | 26 | 25 | 23 | 88 | 27 | 26 | [illegible] | 85 | 31 | 29 | 25 | 77 | 28 | 27 | 23 | [illegible] |
| 15 | 25 | 24 | 21 | 84 | 29 | 25 | 18 | 64 | 31 | 25 | 10 | 41 | 10 | 9 | 5 | [illegible] |
| 16 | 8 | 8 | 3 | 79 | 19 | 19 | 16 | 33 | 26 | 25 | 24 | 91 | [illegible] | [illegible] | 29 | 90 |
| 17 | 31 | 30 | 28 | 90 | 33 | 32 | 31 | 91 | 33 | 32 | 31 | 93 | 34 | [illegible] | 32 | 93 |
| 18 | 35 | 34 | 32 | 90 | 37 | 36 | 34 | 89 | 36 | 35 | 34 | [illegible] | 37 | 36 | 35 | 93 |
| 19 | 37 | 37 | 36 | 96 | 38 | 37 | 36 | 93 | 40 | 39 | 38 | [illegible] | [illegible] | 35 | 35 | [illegible] |
| 20 | 36 | 36 | 35 | 96 | 35 | 35 | 35 | 98 | 40 | 38 | 36 | 87 | 37 | [illegible] | [illegible] | 91 |
| 21 | 31 | 29 | 25 | 79 | 33 | 30 | 26 | 76 | 30 | 29 | 27 | [illegible] | [illegible] | [illegible] | [illegible] | 86 |
| 22 | 28 | 27 | 22 | 78 | 30 | 27 | 19 | 64 | 32 | 30 | 26 | 79 | 32 | 31 | 29 | 86 |
| 23 | 32 | 32 | 31 | 96 | 36 | 35 | 33 | 91 | 37 | 34 | [illegible] | 71 | [illegible] | [illegible] | 32 | 98 |
| 24 | 35 | 34 | 33 | 93 | 32 | 32 | 32 | 99 | 34 | 33 | 32 | [illegible] | 33 | 33 | 32 | 96 |
| 25 | 36 | 35 | 33 | 88 | 36 | 36 | 35 | 95 | 35 | 34 | 32 | 92 | 35 | 34 | 32 | 99 |
| 26 | 35 | 34 | 33 | 91 | 35 | 34 | 33 | 91 | 37 | 35 | 33 | 87 | 36 | 34 | 32 | 88 |
| 27 | 35 | 33 | 32 | 86 | 35 | 34 | 32 | 89 | 36 | 34 | 32 | 57 | 35 | 35 | 35 | 59 |
| 28 | 36 | 35 | 34 | 91 | 35 | 34 | 33 | 90 | 36 | 36 | 35 | 94 | 33 | 33 | 33 | 97 |
| 29 | 30 | 29 | 27 | 88 | 37 | 32 | 23 | 57 | 44 | 38 | 29 | 56 | 34 | [illegible] | 31 | [illegible] |
| 30 | 35 | 35 | 32 | 90 | 38 | 36 | 34 | 85 | 40 | 33 | 30 | 68 | 35 | [illegible] | 32 | 58 |
| 31 | 35 | 34 | 32 | 67 | 40 | 36 | 30 | 67 | 43 | 37 | 31 | [illegible] | 37 | 35 | 32 | 52 |
| MEAN | 25.2 | 23.9 | 17.2 | 75 | 27.3 | 25.3 | 18.3 | 72 | 29.9 | 27.1 | 19.8 | 70 | [illegible] | [illegible] | [illegible] | 73 |
| Normal | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

WIND—Number of hours this month below 10 mi. ........ ; 10 mi. and over ........ ; 15 mi. and over ........ ; 20 mi. and over ........ ; 25 mi. and over ........ ; 32 mi. and over ........ ; 40 mi. and over ........

| This Month—Dir. | N | NE | E | SE | S | SW | W | NW | DI | Month |
|---|---|---|---|---|---|---|---|---|---|---|
| Aver. Hrly. Vel. | | | | | | | | | | |
| Percent of Time | | | | | | | | | | |

Maximum velocity this month since ........ miles from ........ on ........ in ........

CEILING AND VISIBILITY FREQUENCIES (Based on hourly record observations) at ........

| Visibility (miles) | Ceiling (feet) 0 | 100-200 | 300-400 | 500-900 | 1000-1900 | 2000-2900 | 3000-4900 | 5000-9500 | Over 9500 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 to 1/4 | | | | | | | | | | |
| 1/4 to 1/2 | | | | | | | | | | |
| 1/2 to 3/4 | | | | 6 | | | | | | [illegible] |
| 1 to 2 1/2 | | | | 15 | 32 | 11 | 1 | | | 59 |
| 3 to 6 | | | | 1 | 14 | 50 | [illegible] | 1 | 3 | [illegible] |
| 7 to 15 | | | | 2 | 24 | 53 | 113 | 14 | [illegible] | [illegible] |
| 20 to 30 | | | | | | 7 | 52 | 43 | 171 | [illegible] |
| 35 or more | | | | | | | | | | |
| Total | | | | 34 | 70 | 121 | 227 | 68 | [illegible] | [illegible] |

Frequencies for larger classes can be derived by addition, i.e., "Under 500 feet" from sum of 0, 100-200 and 300-400 classes; "7 miles or more" from sum of classes 7 to 35 miles or more inclusive.

FROST DATA—Average date of last killing frost in spring May 4; first in autumn September 26
Latest date of last killing frost in spring May 31, 1950; earliest in autumn August 26, 1948
Average growing season 151 days; longest 175 days in 1947; shortest 115 days in 1948

GENERAL SUMMARY— The unseasonably cold weather during the first half of the month brought the mean temperature to the lowest March Juneau airport record. The lowest of any March minimum temperature occurred on the 4th. This was also the coldest mean March temperature of any on record for the city of Juneau, being ... of a degree lower than the mean temperature that was recorded there in 1916. The precipitation was above normal for the first time since September 1950.

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## APPENDIX C

## DURATION OF SUNSHINE RECORDS

U. S. Weather Bureau, Juneau (Airport) Station, Alaska

(Records obtained with Standard W. B. Mercury Sunshine Recorders)

| Date | Possible** August | Actual Duration* 1949 August | 1950 August | 1951 August | Possible** January |
|---|---|---|---|---|---|
| 1 | 990 | 8:36 | 0:00 | 0:10 | 390 |
| 2 | 986 | 0:00 | 0:19 | 1:37 | 393 |
| 3 | 980 | 2:21 | 0:00 | 2:16 | 394 |
| 4 | 976 | 4:09 | 0:00 | 0:28 | 397 |
| 5 | 972 | 0:00 | 6:35 | 0:43 | 398 |
| 6 | 967 | 0:00 | 12:58 | 0:00 | 401 |
| 7 | 963 | 0:00 | 5:44 | 0:00 | 403 |
| 8 | 958 | 0:00 | 7:17 | 0:39 | 406 |
| 9 | 954 | 0:23 | 11:43 | 12:57 | 408 |
| 10 | 948 | 10:60 | 11:30 | 15:48 | 411 |
| 11 | 944 | 15:44 | 8:52 | 15:44 | 414 |
| 12 | 938 | 0:00 | 5:18 | 12:18 | 418 |
| 13 | 934 | 0:00 | 2:24 | 4:03 | 421 |
| 14 | 929 | 0:17 | 12:08 | 0:05 | 424 |
| 15 | 925 | 0:00 | 15:25 | 0:53 | 427 |
| 16 | 919 | 0:44 | 15:19 | 0:00 | 430 |
| 17 | 914 | 0:00 | 14:35 | 0:00 | 434 |
| 18 | 910 | 5:27 | 15:10 | 0:44 | 437 |
| 19 | 905 | 15:05 | 4:12 | 0:13 | 442 |
| 20 | 900 | 15:00 | 12:08 | 0:00 | 446 |
| 21 | 896 | 14:44 | 14:52 | 2:45 | 450 |
| 22 | 890 | 14:32 | 14:20 | 0:00 | 455 |
| 23 | 885 | 10:32 | 0:25 | 0:00 | 458 |
| 24 | 881 | 14:41 | 3:06 | 0:00 | 462 |
| 25 | 876 | 14:36 | 0:00 | 0:00 | 466 |
| 26 | 871 | 12:04 | 0:00 | 6:04 | 471 |
| 27 | 866 | 14:23 | 0:00 | 7:52 | 475 |
| 28 | 860 | 14:20 | 0:00 | 10:11 | 479 |
| 29 | 855 | 14:12 | 0:00 | 9:48 | 484 |
| 30 | 851 | 12:36 | 4:41 | 7:07 | 488 |
| 31 | 846 | 0:00 | 9:37 | 8:03 | 492 |
| Sums | 28489 | 214:29 | 408:38 | 120:18 | 13474 |
| Percentage of sunshine: | | 45 | 44 | 25 | |

*Actual hours that the sun did shine, recorded in hours and minutes.

**Total hours of possible sunshine, recorded in minutes.

APPENDIX D

MONTHLY TEMPERATURE AND PRECIPITATION RECORD

Station: Juneau, Alaska

Standard of time in use: 120th Meridian Time of Observation: 0720 PST

| | January | | | February | | | March | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Temp. (°F.) | | Precip. (In.) | Temp. (°F.) | | Precip. (In.) | Temp. (°F.) | | Precip. (In.) |
| | Max. | Min. | | Max. | Min. | | Max. | Min. | |
| 1 | 38 | 34 | .24 | 28 | 23 | T | 33 | 24 | .08 |
| 2 | 35 | 25 | .01 | 36 | 22 | .0 | 33 | 28 | .05 |
| 3 | 34 | 24 | .0 | 34 | 17 | .0 | 30 | 17 | .18 |
| 4 | 25 | 18 | .0 | 18 | 12 | .0 | 19 | 0 | T |
| 5 | 24 | 18 | T | 13 | 11 | T | 5 | -1 | .01 |
| 6 | 36 | 23 | .57 | 17 | 11 | .0 | 12 | 2 | .0 |
| 7 | 42 | 36 | .99 | 21 | 11 | .0 | 18 | 13 | .0 |
| 8 | 41 | 34 | .18 | 20 | 16 | .14 | 18 | 13 | .0 |
| 9 | 38 | 32 | 1.02 | 22 | 13 | T | 19 | 13 | .0 |
| 10 | 35 | 30 | .13 | 23 | 10 | .0 | 20 | 13 | .0 |
| 11 | 32 | 30 | .04 | 24 | 10 | .0 | 18 | 12 | T |
| 12 | 35 | 30 | .08 | 23 | 11 | .0 | 30 | 16 | .33 |
| 13 | 36 | 28 | .28 | 27 | 15 | T | 35 | 25 | .31 |
| 14 | 29 | 24 | .26 | 30 | 25 | .18 | 33 | 26 | .10 |
| 15 | 31 | 21 | .01 | 33 | 28 | .52 | 34 | 27 | T |
| 16 | 22 | 13 | T | 39 | 32 | 1.29 | 36 | 15 | T |
| 17 | 16 | 9 | .0 | 38 | 32 | .78 | 34 | 20 | .26 |
| 18 | 17 | 9 | .01 | 38 | 32 | .03 | 40 | 30 | 1.01 |
| 19 | 17 | 11 | T | 36 | 32 | .98 | 41 | 37 | 1.31 |
| 20 | 18 | 11 | T | 38 | 30 | .04 | 40 | 35 | .38 |
| 21 | 25 | 20 | .02 | 37 | 29 | T | 41 | 30 | .55 |
| 22 | 21 | 14 | .02 | 36 | 31 | .12 | 35 | 27 | .08 |
| 23 | 17 | 11 | .06 | 37 | 33 | .51 | 36 | 28 | .20 |
| 24 | 12 | 9 | .02 | 37 | 32 | T | 39 | 30 | .45 |
| 25 | 11 | 7 | .01 | 37 | 23 | .0 | 39 | 32 | .63 |
| 26 | 14 | 8 | .0 | 28 | 18 | .0 | 40 | 34 | .48 |
| 27 | 19 | 11 | .0 | 29 | 18 | T | 38 | 34 | .24 |
| 28 | 24 | 10 | .0 | 32 | 26 | .16 | 39 | 35 | .10 |
| 29 | 19 | 10 | .0 | -- | -- | --- | 38 | 29 | .24 |
| 30 | 25 | 12 | T | -- | -- | --- | 45 | 30 | .02 |
| 31 | 29 | 19 | T | -- | -- | --- | 42 | 35 | .03 |
| Sum | 817 | 592 | 3.95 | 831 | 603 | 4.75 | 980 | 709 | 7.40 |
| Mean | 26.4 | 19.1 | | 29.7 | 21.5 | | 31.6 | 22.8 | |
| Extreme | 42 | 7 | 1.02 | 39 | 10 | 1.29 | 45 | -1 | 1.31 |
| Monthly Mean: | 22.8 | | | 25.6 | | | 27.2 | | |
| Normal: | 27.8 | | 7.16 | 30.1 | | 5.53 | 33.8 | | 5.51 |

|  | Actual Duration* |  |  | Actual Duration* |  |  |
|---|---|---|---|---|---|---|
| 1949 January | 1950 January | 1951 January | Possible** February | 1949 February | 1950 February | 1951 February |
| 0:54 | 3:04 | 0:00 | 497 | 0:00 | 0:00 | 8:17 |
| 0:00 | 0:00 | 3:53 | 501 | 8:20 | 2:04 | 8:21 |
| 0:00 | 5:41 | 6:34 | 506 | 7:46 | 0:00 | 8:26 |
| 0:00 | 0:00 | 0:15 | 510 | 5:60 | 2:18 | 4:35 |
| 0:00 | 0:55 | 0:00 | 516 | 0:15 | 4:13 | 8:36 |
| 1:50 | 4:48 | 0:00 | 520 | 8:39 | 2:45 | 8:40 |
| 1:43 | 3:48 | 0:00 | 525 | 0:00 | 3:14 | 0:00 |
| 0:00 | 6:46 | 0:00 | 529 | 5:32 | 1:53 | 4:29 |
| 0:00 | 4:30 | 0:00 | 533 | 0:00 | 3:48 | 8:53 |
| 0:00 | 6:21 | 0:00 | 539 | 7:28 | 0:00 | 8:59 |
| 0:00 | 6:25 | 3:25 | 543 | 8:70 | 4:08 | 9:03 |
| 0:00 | 6:58 | 0:00 | 549 | 0:00 | 0:43 | 3:16 |
| 0:00 | 5:48 | 0:00 | 553 | 0:13 | 2:52 | 0:00 |
| 0:00 | 7:04 | 0:00 | 559 | 6:56 | 0:21 | 0:00 |
| 0:00 | 5:38 | 0:28 | 564 | 0:00 | 3:27 | 0:00 |
| 0:00 | 7:10 | 7:10 | 569 | 6:19 | 1:53 | 0:00 |
| 0:00 | 0:00 | 2:09 | 574 | 8:49 | 4:53 | 1:35 |
| 1:42 | 6:07 | 0:00 | 580 | 9:39 | 0:30 | 0:00 |
| 1:29 | 7:22 | 2:12 | 584 | 9:43 | 3:23 | 1:00 |
| 0:00 | 3:41 | 0:00 | 589 | 9:48 | 3:43 | 6:09 |
| 7:29 | 5:40 | 4:36 | 594 | 2:36 | 3:00 | 4:02 |
| 7:34 | 7:35 | 0:00 | 599 | 3:46 | 0:00 | 0:00 |
| 0:00 | 7:38 | 0:00 | 604 | 0:00 | 2:37 | 0:40 |
| 0:00 | 5:49 | 0:00 | 609 | 1:20 | 2:14 | 3:46 |
| 0:00 | 7:46 | 3:17 | 614 | 0:00 | 0:42 | 3:18 |
| 0:00 | 7:51 | 7:51 | 619 | 0:00 | 2:38 | 0:00 |
| 4:28 | 7:55 | 7:55 | 624 | 0:00 | 4:47 | 0:00 |
| 0:00 | 7:59 | 7:19 | 629 | 0:26 | 0:00 | 6:16 |
| 0:00 | 8:04 | 4:13 | 629 | ---- | ---- | ---- |
| 0:33 | 6:00 | 0:00 | --- | ---- | ---- | ---- |
| 7:21 | 0:00 | 0:00 | --- | ---- | ---- | ---- |
| 50:3 | 167:16 | 61:17 |  | 170:25 | 52:06 | 108:22 |
| 22 | 74 | 27 |  | 42 | 23 | 41 |

APPENDIX E

## MONTHLY TEMPERATURE AND PRECIPITATION RECORD

Station: Annex Creek, Alaska

Standard of time in use: 120th Meridian Time of Observation: 0720 PST

| Date | January Temp. (°F.) Max. | January Temp. (°F.) Min. | January Precip. (In.) | February Temp. (°F.) Max. | February Temp. (°F.) Min. | February Precip. (In.) | March Temp. (°F.) Max. | March Temp. (°F.) Min. | March Precip. (In.) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 42 | 39 | 1.32 | 29 | 10 | T | 32 | 24 | .80 |
| 2 | 40 | 34 | .80 | 31 | 20 | .0 | 32 | 24 | .60 |
| 3 | 39 | 33 | .20 | 25 | 10 | .0 | 30 | 20 | T |
| 4 | 35 | 3 | .18 | 17 | 6 | .0 | 24 | -2 | .0 |
| 5 | 14 | 4 | T | 12 | 6 | .0 | 8 | 0 | .0 |
| 6 | 29 | 8 | .10 | 13 | 0 | .0 | 22 | 5 | .0 |
| 7 | 28 | 10 | .30 | 20 | 11 | T | 18 | 12 | .0 |
| 8 | 40 | 15 | 1.20 | 21 | 12 | E1.09 | 22 | 13 | .0 |
| 9 | 32 | 26 | .12 | 24 | 8 | .0 | 21 | 14 | .0 |
| 10 | 29 | 26 | T | 16 | 2 | .0 | 23 | 16 | .0 |
| 11 | 38 | 28 | .30 | 11 | -2 | .0 | 21 | 13 | .30 |
| 12 | 38 | 34 | .20 | 12 | -2 | .0 | 28 | 18 | .09 |
| 13 | 36 | 34 | T | 24 | 7 | .0 | 34 | 25 | .08 |
| 14 | 36 | 30 | .16 | 31 | 16 | .18 | 32 | 26 | .0 |
| 15 | 30 | 26 | .20 | 38 | 28 | .80 | 36 | 14 | .40 |
| 16 | 31 | 22 | T | 42 | 32 | .20 | 30 | 13 | .48 |
| 17 | 26 | 5 | T | 38 | 32 | .10 | 28 | 24 | .60 |
| 18 | 16 | 4 | T | 37 | 30 | T | 36 | 22 | .80 |
| 19 | 10 | 8 | .10 | 36 | 30 | .0 | 28 | 28 | .15 |
| 20 | 12 | 8 | .0 | 37 | 28 | .30 | 41 | 32 | .10 |
| 21 | 10 | 4 | T | 38 | 34 | .29 | 38 | 29 | .30 |
| 22 | 10 | 6 | T | 40 | 30 | 1.04 | 34 | 29 | .60 |
| 23 | 10 | 8 | .0 | 38 | 30 | .40 | 42 | 20 | 1.40 |
| 24 | 10 | 6 | T | 35 | 20 | .0 | 34 | 32 | .80 |
| 25 | 16 | 7 | .0 | 27 | 14 | .18 | 42 | 33 | .20 |
| 26 | 14 | 6 | .0 | 24 | 16 | .20 | 41 | 34 | .30 |
| 27 | 8 | 4 | .0 | 29 | 19 | E.18 | 41 | 33 | .18 |
| 28 | 8 | -3 | T | 32 | 19 | .80 | 38 | 32 | T |
| 29 | 6 | -6 | .0 | -- | -- | --- | 43 | 31 | .0 |
| 30 | 12 | 1 | .0 | -- | -- | --- | 44 | 34 | T |
| 31 | 15 | 8 | .08 | -- | -- | --- | 49 | 33 | .10 |
| Sum | 720 | 432 | 5.26 | 777 | 466 | E5.76 | 992 | 682 | 8.28 |
| Mean | 23.2 | 13.9 | | 27.8 | 15.6 | | 32.0 | 21.7 | |
| Extreme | 42 | -6 | 1.32 | 42 | -2 | E1.09 | 44 | -2 | 1.40 |
| Monthly Mean: | 18.6 | | | 22.2 | | | 26.9 | | |
| Departure from Normal: | -5.1 | | -3.77 | -3.7 | | -1.38 | -5.4 | | 1.96 |
| Total Snowfall | | | 3.90 | | | 72.5 | | | 117.0 |

APPENDIX F (1)

TEMPERATURES AND PRECIPITATION RECORDED AT BIG BULL MINE, TULSEQUAH, B.C.

## TEMPERATURES

| | | MEAN MAXIMUM | MEAN MINIMUM | MEAN | MEAN RANGE |
|---|---|---|---|---|---|
| November | 1949 | 39.7 ° | 32.0 ° | 35.85° | 7.7 ° |
| December | 1949 | 20.1 ° | 9.2 ° | 14.7 ° | 10.9 ° |
| January | 1950 | 12.5 ° | -3.3 ° | 4.6 ° | 15.8 ° |
| February | 1950 | 23.8 ° | 9.9 ° | 16.9 ° | 13.9 ° |
| March | 1950 | 46.7 ° | 24.0 ° | 35.4 ° | 22.7 ° |
| April | 1950 | 52.6 ° | 31.6 ° | 42.1 ° | 21.0 ° |
| May | 1950 | 61.8 ° | 39.5 ° | 50.7 ° | 22.3 ° |
| June | 1950 | 74.9 ° | 46.7 ° | 60.8 ° | 28.2 ° |
| July | 1950 | 68.9 ° | 47.6 ° | 58.25° | 21.3 ° |
| August | 1950 | 70.45° | 45.38° | 57.92° | 25.07° |
| September | 1950 | 58.8 ° | 42.2 ° | 50.5 ° | 16.6 ° |
| October | 1950 | 46.5 ° | 31.1 ° | 38.8 ° | 15.4 ° |
| November | 1950 | 19.3 ° | 8.78° | 14.04° | 10.52° |
| December | 1950 | 25.2 ° | 18.0 ° | 21.6 ° | 7.2 ° |
| January | 1951 | 13.42° | 5.32° | 9.37° | 8.10° |
| February | 1951 | 24.78° | 10.86° | 17.82° | 13.92° |
| March | 1951 | 35.9 ° | 15.5 ° | 25.7 ° | 20.4 ° |

Mean Maximum: Average for month of daily maximum readings
Mean Minimum: Average for month of daily minimum readings
Mean : Average for month
Mean Range : Range between mean maximum and mean minimum readings
Rain : Measured to nearest hundredth
Snow : Precipitation - 1/10 of snowfall in inches

PRECIPITATION:

| HIGHEST TEMPERATURE | LOWEST TEMPERATURE | RAIN | SNOW | TOTAL | |
|---|---|---|---|---|---|
| 56° on 11th | 24° on 30th | -- | -- | -- | |
| 36° on 13th | -19° on 30th | -- | -- | -- | |
| | | | | | |
| 43° on 29th | -23° on 1st | -- | -- | (estimated) | .5 " |
| 48° on 28th | - 3° on 9th | -- | -- | " | 1.8 " |
| 58° on 27th | 6° on 13th | -- | -- | " | 2.4 " |
| 65° on 2nd | 25° on 22nd | .06 | -- | " | .06" |
| 79° on 7th | 32° on 16th | .63 | -- | " | .63" |
| 85° on 19th | 35° on 4th | .88 | -- | " | .88" |
| 85° on 22nd | 38° on 8th | 2.83 | -- | " | 2.83" |
| 86.5° on 9th | 36° on 16th | 4.14 | -- | " | 4.14" |
| 69° on 13th | 34° on 28th | 5.76 | -- | " | 5.76" |
| 56.5° on 4th | 11° on 31st | 1.73 | 1.03 | " | 2.76" |
| 50° on 6th | -4° on 22nd | .06 | .69 | " | .72" |
| 36° on 10th | -1° on 4th | | 4.70 | " | 4.70" |
| | | | | | 27.18" |
| | | | | | |
| 36° on 1st | -15° on 28th | -- | 5.71 | " | 5.71" |
| 47° on 23rd | -15° on 6th | .21 | 2.49 | " | 2.70" |
| 60° on 29th | - 5° on 5th | .61 | 4.02 | " | 4.63" |

APPENDIX F (2)

BRIEF SUMMARY OF WEATHER AT BIG BULL MINE, TULSEQUAH, B. C.

MONTHLY PERIOD

November, 1949:

No record of precipitation for this month, but there was continued cloudiness throughout the second and third week with light rain showers.

December, 1949:

Light rain and snow flurries during first week with clear weather until middle of third week when there was a heavy snowfall with much cloudiness. The weather cleared again during the last part of the month.

January, 1950:

With the exception of a few days during the third week, the weather remained clear during the whole month.

February, 1950:

Persistent cloudiness with snowfalls throughout the month except for the last four or five days.

March, 1950:

The first few days were cloudy, but the rest of the month remained clear. A little high cloudiness developed during the last week.

April, 1950:

First two weeks of period cloudy, but very little precipitation. Last two weeks clear weather with last few days with high cloudiness.

May, 1950:

Cloudiness persisted throughout the first week giving way to a period of clear weather. During latter part of month cloudiness again developed.

June, 1950:

Perfectly clear weather for the first three weeks of the period, changing to scattered cloudiness and occasional showers during last week.

July, 1950:

Continued cloudiness throughout the month with rainfall of slightly less than three inches.

August, 1950:

High cloudiness during first part, turned to low cloudiness with rain during second week. The third week was clear. Last part of period weather poor with heavy rains.

September, 1950:

Heavy rains continued throughout first part of month, clearing up for a brief period and then continuing throughout the last half of the month.

October, 1950:

Cloudiness persisted throughout the month with little precipitation in the form of both rain and snow.

November, 1950:

Mostly cloudy during the whole month, but with very little precipitation.

December, 1950:

Scattered cloudiness with snow flurries with the exception of three days heavy snowfall on December 4th, 5th, and 6th.

January, 1951:

During the first part of the period there was much cloudiness with heavy snowfalls. The middle of the month was clear, but clouded up again at the end of the month.

February, 1951:

Clear weather with strong north winds during the first two weeks of the period, turning cloudy during latter half of the period.

March, 1951:

First two weeks of period weather was clear and cold. Weather warmed up and there was much cloudiness with a few heavy snowfalls during last week of month.

APPENDIX G

Cable 151 (1st sheet)

| No. | Thermo | Reading | Equiv | Reading | Equiv | Reading | Equiv | Reading | Equiv | Reading | Equiv | Reading | Equiv |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Date-Time | 2/13/51 7 pm | | 2/13/51 2200 | | 2/13/51 0700 | | 2/13/51 1000 | | 2/13/51 1300 | | 2/13/51 1600 | |
| 1 | 1189 | 04450 -3.7 | -10.66 | 05640 | -10.60 | 05300 | -10.70 | 04500 | -7.03 | 03459 | -4.11 | 04040 | -5.06 |
| 2 | 1190 | 07770 -3.6 | -16.31 | 5690 | -18.28 | 5600 | -10.93 | 4410 | -6.80 | 3709 | -3.81 | 4190 | -5.56 |
| 3 | 1191 | 07160 -3.6 | -16.62 | 5590 | -18.06 | 5690 | -10.52 | 4560 | -6.58 | 3909 | -3.64 | 4100 | -6.28 |
| 4 | 1192 | 06660 -3.6 | -8.32 | 5500 | -17.64 | 5600 | -10.81 | 4590 | -6.67 | 3900 | -3.72 | 4100 | -6.96 |
| 5 | 1193 | 04340 -3.7 | -12.72 | 5400 | -12.17 | 5590 | -10.51 | 4590 | -6.17 | 3700 | -3.67 | 4170 | -6.17 |
| 6 | 1194 | 06650 -3.5 | -12.66 | 7790 | -16.36 | 5440 | -10.95 | 4590 | -6.52 | 3770 | -3.72 | 4100 | -5.89 |
| 7 | 1195 | 05560 -3.6 | -13.17 | 8000 | -16.31 | 5400 | -10.08 | 4500 | -7.46 | 3870 | -3.22 | 4200 | -6.10 |
| 8 | 1196 | 06150 -3.6 | -12.97 | 7050 | -16.21 | 5780 | -10.80 | 4550 | +6.60 | 4100 | -4.55 | 4050 | -5.78 |
| 9 | 1197 | 06150 -3.6 | -12.03 | 6540 | -15.79 | 5460 | -10.40 | 4770 | -6.89 | 3700 | -4.37 | 4000 | -6.11 |
| | | 2/13 1900 | | 2/13 2200 | | 2/14 0700 | | 2/14 1000 | | 2/14 1300 | | 2/14 1600 | |
| 1 | 1189 | 04490 -3.7 | [illegible] | 04490 | -2.07 | 04040 | -6.01 | 03420 | -1.86 | 03500 | +2.00 | 03930 | [illegible] |
| 2 | 1190 | 9790 -3.6 | [illegible] | 9490 | -2.06 | 9450 | -2.80 | 3550 | -2.02 | 3890 | +1.90 | 3950 | [illegible] |
| 3 | 1191 | 9850 -3.6 | [illegible] | 9410 | -2.02 | 9400 | -2.80 | 3610 | -2.06 | 3100 | +0.87 | 3550 | [illegible] |
| 4 | 1192 | 9790 -3.6 | [illegible] | 9510 | -2.00 | 9370 | -2.30 | 3630 | -2.38 | 3000 | +1.92 | 3500 | [illegible] |
| 5 | 1193 | 9770 -3.7 | [illegible] | 9600 | -2.26 | 9300 | -6.07 | 3540 | +1.91 | 3000 | +1.18 | 3930 | [illegible] |
| 6 | 1194 | 9990 -3.5 | [illegible] | 9580 | -2.11 | 9160 | -6.82 | 3550 | +2.02 | 3590 | +1.88 | 3500 | [illegible] |
| 7 | 1195 | 9850 -3.6 | [illegible] | 9540 | -2.10 | 9400 | -6.60 | 3550 | +1.87 | 3110 | +1.19 | 3590 | [illegible] |
| 8 | 1196 | 9830 -3.6 | [illegible] | 9770 | -2.31 | 9400 | -6.91 | 3660 | +2.37 | 3060 | +1.06 | 3970 | [illegible] |
| 9 | 1197 | 9860 -3.6 | [illegible] | 9990 | -2.26 | 9460 | -6.07 | 3560 | +2.53 | 3090 | +2.18 | 3940 | [illegible] |
| | | 2/14 1900 | | 2/14 2200 | | 2/15 0100 | | 2/15 1000 | | 2/15 1300 | | 2/15 [illegible] | |
| 1 | 1189 | 09300 -3.7 | [illegible] | 4950 | -6.82 | 03980 | -4.20 | 03100 | -3.36 | 03190 | [illegible] | 03540 | [illegible] |
| 2 | 1190 | 9400 -3.6 | -5.07 | 9560 | -6.08 | 3910 | -4.14 | 3310 | -3.36 | 3310 | [illegible] | 3400 | [illegible] |
| 3 | 1191 | 9930 -3.6 | -5.03 | 9550 | -6.05 | 4010 | -4.18 | 3370 | -3.62 | 3970 | [illegible] | 3770 | [illegible] |
| 4 | 1192 | 9960 -3.6 | [illegible] | 9510 | -6.34 | 4010 | -4.18 | 3550 | +3.37 | 3910 | -1.66 | 3790 | [illegible] |
| 5 | 1193 | 9960 -3.7 | -5.37 | 9040 | -6.25 | 3940 | -4.16 | 3500 | +3.56 | 3970 | -1.63 | 3760 | [illegible] |
| 6 | 1194 | 9960 -3.5 | [illegible] | 9040 | -6.24 | 3840 | -4.12 | 3710 | +3.36 | 3900 | -1.30 | 3640 | [illegible] |
| 7 | 1195 | 9590 -3.6 | -5.23 | 9570 | -6.41 | 4110 | -4.18 | 3990 | -3.56 | 3600 | -1.69 | 3930 | [illegible] |
| 8 | 1196 | 9590 -3.6 | [illegible] | 9590 | -6.60 | 4000 | -4.50 | 3460 | +3.61 | 3550 | -1.79 | 3950 | [illegible] |
| 9 | 1197 | 9150 -3.6 | -5.31 | 9590 | -6.07 | 3910 | -4.12 | 3740 | +2.07 | 3560 | -2.50 | 3710 | [illegible] |
| | | 2/15 1900 | | 2/15 2200 PM | | 2/16 10:10 AM | | 2/16 1300 | | 2/16 1600 | | 2/16 [illegible] | |
| 1 | 1189 | 03800 -3.7 | [illegible] | 03910 | +4.00 | 03790 | -3.77 | 03350 | -10.09 | 03540 | -2.41 | 04310 | [illegible] |
| 2 | 1190 | 03920 -3.6 | [illegible] | 9010 | -4.31 | 3790 | -3.06 | 3330 | -1.05 | 3600 | -2.47 | 4030 | [illegible] |
| 3 | 1191 | 03950 -3.6 | [illegible] | 9070 | +4.35 | 3950 | -3.97 | 3500 | -1.07 | 3760 | -2.09 | 3310 | [illegible] |
| 4 | 1192 | 04000 -3.6 | [illegible] | 9050 | +4.35 | 3910 | -3.77 | 3460 | -1.39 | 3790 | -2.85 | 4140 | [illegible] |
| 5 | 1193 | 03990 -3.7 | -6.15 | 9000 | +4.35 | 3050 | -3.01 | 3050 | -1.52 | 3700 | -2.97 | 4100 | [illegible] |
| 6 | 1194 | 33990 -3.5 | [illegible] | 3840 | -4.31 | 3990 | -3.97 | 3370 | -1.63 | 3600 | -2.96 | 4110 | [illegible] |
| 7 | 1195 | 34100 -3.6 | [illegible] | 4110 | -4.15 | 4010 | -3.78 | 3630 | -1.80 | 3960 | -2.97 | 4310 | [illegible] |
| 8 | 1196 | 04100 -3.6 | -1.69 | 4150 | -4.72 | 4010 | -4.15 | 3610 | -2.11 | 3850 | -2.33 | 4110 | [illegible] |
| 9 | 1197 | 03900 -3.6 | [illegible] | 3940 | -4.34 | 3900 | -2.08 | 3540 | -2.43 | 3700 | -2.28 | 4170 | [illegible] |



APPENDIX G

Cable 151 (2nd sheet)

| No. | Thermo | Reading | Equiv | Reading | Equiv | Reading | Equiv | Reading | Equiv | Reading | Equiv | Reading | Equiv |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Date-Time | 2/16 2200 PST | | 2/17 0700 PST | | 2/17 1000 PST | | 2/17 1300 PST | | 2/17 1900 PST | | 2/17 10 pm | |
| 1 | 1189 | 04100 -3.7 | -5.27 | 05580 | -10.98 | 05700 | -12.03 | 03550 | -2.87 | 04700 | -2.83 | 04600 | -7.48 |
| 2 | 1190 | 4140 -3.6 | -5.16 | 5610 | -10.57 | 5460 | -10.04 | 3650 | -2.75 | 4140 | -2.64 | 4760 | -7.62 |
| 3 | 1191 | 4150 -3.6 | -5.15 | 5610 | -10.26 | 5460 | -9.77 | 3960 | -3.82 | — | — | 4830 | -7.52 |
| 4 | 1192 | 4430 -3.6 | -5.18 | 5530 | -10.09 | 5410 | -9.72 | 4460 | -4.38 | 4890 | -3.84 | 4800 | -7.50 |
| 5 | 1193 | 4170 -3.7 | -5.12 | 5410 | -9.93 | 5110 | -8.88 | 4030 | -4.45 | 4752 | -3.65 | 4700 | -7.38 |
| 6 | 1194 | 4070 -3.5 | -5.11 | 5640 | -9.88 | 4900 | -8.16 | 4010 | -4.83 | 4010 | -9.71 | 4590 | -7.18 |
| 7 | 1195 | 4140 -3.6 | -4.09 | 5550 | -9.84 | 4900 | -7.45 | 4060 | -3.93 | 4490 | -5.81 | 4800 | -7.06 |
| 8 | 1196 | 4140 -3.6 | -4.96 | 5070 | -9.80 | 4450 | -7.61 | 4110 | -4.82 | 4750 | -7.35 | 4760 | -7.37 |
| 9 | 1197 | 4070 -3.6 | -5.07 | 4490 | -3.84 | 4150 | -6.31 | 3900 | -3.77 | 4740 | -7.90 | 4050 | -6.73 |
| | | 2/18 1 AM | | 2/18 4 AM | | 2/18 7 AM | | 2/18 10 AM | | 2/18 1 pm | | 2/18 4 pm | |
| 1 | 1189 | 04400 -3.7 | -6.75 | 04140 | -5.47 | 04190 | -5.47 | 04000 | -4.83 | 03430 | -1.92 | 03750 | -3.62 |
| 2 | 1190 | 4480 -3.6 | -5.55 | 4130 | -5.33 | 4340 | -5.37 | 4130 | -4.79 | 3580 | -2.18 | 03410 | -3.85 |
| 3 | 1191 | 4340 -3.6 | -5.54 | 4140 | -5.32 | 4504 | -5.37 | 4160 | -5.02 | 3430 | -3.67 | 04050 | -4.24 |
| 4 | 1192 | 4320 -3.6 | -5.64 | 4170 | -5.22 | 4390 | -5.41 | 4100 | -6.02 | 3900 | -3.62 | 04040 | -4.29 |
| 5 | 1193 | 4460 -3.7 | -5.51 | 4110 | -5.30 | 4310 | -5.38 | 4150 | -5.03 | 3900 | -3.86 | 04040 | -4.62 |
| 6 | 1194 | 4150 -3.5 | -5.47 | 4110 | -5.29 | 4130 | -5.38 | 4040 | -4.88 | 3780 | -3.72 | 03910 | -4.36 |
| 7 | 1195 | 4910 -3.6 | -5.45 | 4180 | -5.35 | 4400 | -5.43 | 4100 | -5.01 | 4090 | -4.59 | 04100 | -4.70 |
| 8 | 1196 | 4410 -3.6 | -5.57 | 4370 | -5.70 | 4390 | -5.78 | 4190 | -5.35 | 4040 | -4.14 | 04150 | -4.83 |
| 9 | 1197 | 4150 -3.6 | -5.45 | 4140 | -5.28 | 4190 | -5.18 | 4490 | -5.18 | 3870 | -4.12 | 03980 | -4.64 |
| | | 2/18 7 pm | | 2/18 11 pm | | 2/19 1 AM | | 2/19 4 AM | | 2/19 7 AM | | 2/19 10 AM | |
| 1 | 1189 | 04420 -3.7 | -5.38 | 04190 | -6.70 | 04349 | -5.84 | 04150 | -6.97 | 04160 | -6.01 | 04170 | -4.61 |
| 2 | 1190 | 4290 -3.6 | -5.77 | 4330 | -5.77 | 4319 | -5.24 | 4110 | -5.07 | 4300 | -4.64 | 4540 | -4.85 |
| 3 | 1191 | 4310 -3.6 | -5.41 | 4330 | -5.75 | 4374 | -5.24 | 4130 | -5.06 | 4150 | -5.58 | 4550 | [illegible] |
| 4 | 1192 | 4300 -3.6 | -5.46 | 4370 | -5.76 | 4349 | -5.20 | 4120 | -5.11 | 4140 | -4.54 | 4310 | [illegible] |
| 5 | 1193 | 4440 -3.7 | -5.47 | 4340 | -5.78 | 4309 | -5.36 | 4190 | -5.16 | 4490 | -4.43 | 4130 | -4.94 |
| 6 | 1194 | 4140 -3.5 | -5.45 | 4310 | -5.74 | 4010 | -5.20 | [illegible] | -5.02 | [illegible] | -5.38 | 4010 | -4.58 |
| 7 | 1195 | 4400 -3.6 | -5.43 | 4490 | -5.77 | 4350 | -5.22 | 4120 | -5.09 | 4400 | -5.48 | 4310 | -4.61 |
| 8 | 1196 | 4400 -3.6 | -5.82 | 4490 | -6.16 | 4350 | -5.61 | 4320 | -5.48 | 4190 | -6.78 | 4140 | -6.57 |
| 9 | 1197 | 4150 -3.6 | -5.43 | 4140 | -6.83 | 4100 | -5.20 | 4080 | -5.11 | 4190 | -5.38 | 4070 | -5.07 |
| | | 2/19 1:30 pm | | 2/19 4 pm | | 2/19 7 pm | | 2/19 8:30 pm | | 2/19 10 pm | | 2/20 1 AM | |
| 1 | 1189 | 03880 -3.7 | -4.26 | 03140 | -4.85 | 04419 | -5.79 | 04250 | -5.97 | 04240 | -6.14 | 04130 | -6.57 |
| 2 | 1190 | 3980 -3.6 | +1.35 | 3040 | +0.97 | 5010 | -8.47 | 4130 | -7.41 | 3750 | -10.26 | 5560 | -10.36 |
| 3 | 1191 | 3150 -3.6 | +0.57 | 3100 | +0.87 | 4460 | -8.02 | 4130 | -9.10 | 6340 | -14.12 | 5460 | -9.97 |
| 4 | 1192 | 3310 -3.6 | -0.48 | 3140 | +0.46 | 4380 | -7.42 | 4530 | -6.43 | 6050 | -11.65 | 5400 | -9.66 |
| 5 | 1193 | 3190 -3.7 | -0.02 | 3060 | +0.86 | 4540 | -6.62 | 4420 | -6.20 | 5410 | -9.96 | 5470 | -9.44 |
| 6 | 1194 | 3430 -3.5 | -0.96 | 3050 | +0.54 | [illegible] | -6.39 | 4180 | -6.06 | [illegible] | -9.60 | 5190 | -9.60 |
| 7 | 1195 | 3180 -3.6 | -0.42 | 3340 | +0.00 | [illegible] | -6.30 | 4540 | -6.02 | [illegible] | -9.08 | 5190 | -9.15 |
| 8 | 1196 | 3410 -3.6 | -1.02 | 3140 | +0.24 | 4510 | -0.50 | 4500 | -6.24 | [illegible] | -9.13 | 5100 | -9.23 |
| 9 | 1197 | 3560 -3.6 | -0.85 | 3180 | -0.37 | [illegible] | -6.17 | 4140 | -5.83 | 4240 | -8.28 | 5000 | -8.88 |

APPENDIX G

Cable 151 (3rd Test)

| No. | Thermo | 4 AM Ice Adj / Corr | Equiv | 7 AM Ice Adj | Equiv | 10 AM Ice Adj | Equiv | 1 PM Ice Adj | Equiv | 4 PM Ice Adj | Equiv | 1900 PST Ice Adj | Equiv |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1189 | 04300 -3.7 | -7.03 | 04460 | -7.59 | 04640 | -7.79 | 04510 | +7.07 | [illegible] | -7.92 | 05010 | +7.07 |
| 2 | 1190 | 7500 -3.6 | -10.91 | 7750 | -16.71 | 7540 | -10.30 | 3160 | +0.23 | 3380 | -1.06 | 4900 | -12.77 |
| 3 | 1191 | 7100 -3.6 | -14.92 | 7740 | -16.03 | [illegible] | -9.64 | 3490 | -1.36 | [illegible] | [illegible] | 4850 | [illegible] |
| 4 | 1192 | 6800 -3.6 | -13.79 | 7390 | -15.20 | 5580 | -10.25 | 3340 | -2.83 | 3590 | [illegible] | 7500 | -14.56 |
| 5 | 1193 | 6320 -3.7 | -12.54 | 7140 | -14.75 | 4620 | -7.26 | 3630 | -2.76 | | -2.49 | 4490 | [illegible] |
| 6 | 1194 | 5710 -3.5 | -11.38 | 7010 | -14.97 | 4610 | -7.48 | 3840 | -2.72 | | -7.16 | 4490 | -12.07 |
| 7 | 1195 | 5810 -3.6 | -10.57 | 6660 | -13.00 | 4070 | -3.77 | 3700 | -2.36 | | -7.31 | 4900 | -12.27 |
| 8 | 1196 | 5710 -3.6 | -10.52 | 6070 | -11.67 | 4610 | -6.76 | 3960 | +3.76 | 3310 | -2.40 | 4900 | -12.05 |
| 9 | 1197 | 5340 -3.6 | [illegible] | 5340 | -10.01 | 4140 | -3.37 | 3900 | -2.00 | [illegible] | | 5100 | -11.37 |

| No. | Thermo | 10 PM | Equiv | 1 AM | Equiv | 4 AM | Equiv | 7 AM | Equiv | 10 AM | Equiv | 1300 PST | Equiv |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1189 | 05110 -3.7 | -7.3[illegible] | [illegible] | -8.85 | [illegible] | -16.80 | 05700 | +10.05 | 05050 | -7.25 | 04550 | [illegible] |
| 2 | 1190 | 9350 -3.6 | [illegible] | 7160 | -14.75 | [illegible] | -16.19 | 5500 | +9.49 | [illegible] | [illegible] | 3950 | [illegible] |
| 3 | 1191 | 9500 -3.6 | -8.00 | 7040 | -14.97 | [illegible] | -16.80 | 5360 | +9.48 | [illegible] | [illegible] | 3400 | [illegible] |
| 4 | 1192 | 7090 -3.6 | [illegible] | [illegible] | -14.11 | [illegible] | -16.23 | 5340 | -9.45 | [illegible] | [illegible] | 3110 | [illegible] |
| 5 | 1193 | 6560 -3.7 | [illegible] | [illegible] | -12.67 | [illegible] | -10.15 | 5490 | +9.84 | [illegible] | [illegible] | [illegible] | -1.02 |
| 6 | 1194 | 5950 -3.5 | [illegible] | [illegible] | -13.08 | [illegible] | -10.02 | 5090 | +8.21 | [illegible] | [illegible] | 3190 | -4.17 |
| 7 | 1195 | 6190 -3.6 | [illegible] | [illegible] | -12.79 | [illegible] | -9.95 | 5190 | -9.15 | [illegible] | [illegible] | 3500 | [illegible] |
| 8 | 1196 | 6100 -3.6 | [illegible] | [illegible] | -12.61 | [illegible] | -10.00 | 5300 | -9.48 | [illegible] | [illegible] | 3480 | -1.38 |
| 9 | 1197 | 5910 -3.6 | [illegible] | 5790 | -11.4[illegible] | [illegible] | -9.37 | 5010 | -2.9[illegible] | [illegible] | [illegible] | 3990 | -1.82 |

| No. | Thermo | 7 PM | Equiv | 10 PM | Equiv | 1 AM | Equiv | 0400 AM | Equiv | 7 AM | Equiv | 0700 PST | Equiv |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1189 | 04900 -3.7 | -8.5[illegible] | [illegible] | -8.70 | 05000 | -8.97 | [illegible] | -6.8[illegible] | 04650 | -7.78 | 04990 | -8.24 |
| 2 | 1190 | 5100 -3.6 | [illegible] | [illegible] | -16.95 | [illegible] | -6.20 | [illegible] | +6.15 | 4050 | [illegible] | 3900 | [illegible] |
| 3 | 1191 | 5100 -3.6 | [illegible] | [illegible] | -10.09 | [illegible] | -6.17 | [illegible] | -6.21 | [illegible] | -10.27 | 3100 | -6.46 |
| 4 | 1192 | 5000 -3.5 | [illegible] | [illegible] | -6.94 | [illegible] | -6.18 | [illegible] | +6.92 | [illegible] | [illegible] | 3110 | [illegible] |
| 5 | 1193 | 4930 -3.7 | [illegible] | [illegible] | -6.73 | [illegible] | -6.16 | [illegible] | +6.12 | 5050 | -7.64 | 3070 | [illegible] |
| 6 | 1194 | 4660 -3.5 | [illegible] | [illegible] | -6.22 | [illegible] | -6.14 | [illegible] | -6.66 | [illegible] | [illegible] | [illegible] | [illegible] |
| 7 | 1195 | 4900 -3.6 | [illegible] | [illegible] | -6.42 | [illegible] | -6.71 | [illegible] | +6.66 | [illegible] | -7.51 | [illegible] | [illegible] |
| 8 | 1196 | 4860 -3.6 | [illegible] | [illegible] | -6.84 | [illegible] | -6.57 | [illegible] | +6.73 | [illegible] | [illegible] | [illegible] | [illegible] |
| 9 | 1197 | 4800 -3.6 | -7.24 | 4000 | -6.52 | [illegible] | [illegible] | [illegible] | +6.14 | [illegible] | [illegible] | [illegible] | -6.65 |

| No. | Thermo | 1000 PST | Equiv | 1300 PST | Equiv | 1600 PST | Equiv | 1900 PST | Equiv | 2200 PST | Equiv | 0100 | Equiv |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1189 | 04830 -3.7 | -8.35 | 04610 | -7.47 | [illegible] | -6.10 | 04670 | -7.91 | 04670 | -8.71 | 04990 | -8.90 |
| 2 | 1190 | 4050 -3.6 | -8.57 | 3550 | -2.13 | [illegible] | [illegible] | [illegible] | -5.96 | [illegible] | [illegible] | 4330 | [illegible] |
| 3 | 1191 | 4130 -3.6 | -7.01 | 3750 | -2.99 | [illegible] | -6.97 | 4330 | -5.99 | [illegible] | -6.32 | 04500 | [illegible] |
| 4 | 1192 | 4130 -3.6 | -6.70 | 3750 | -2.98 | [illegible] | -5.11 | 4310 | -5.80 | [illegible] | -5.91 | [illegible] | -6.39 |
| 5 | 1193 | 4090 -3.7 | -6.78 | 3760 | -3.17 | 4160 | [illegible] | 4350 | -5.97 | [illegible] | -5.71 | [illegible] | -6.23 |
| 6 | 1194 | 4080 -3.5 | -6.79 | 3690 | -3.29 | 4050 | -5.03 | 4150 | -5.97 | [illegible] | -5.63 | 4310 | -5.17 |
| 7 | 1195 | 4330 -3.6 | -6.88 | 3990 | -2.89 | 4350 | -6.05 | 4410 | -5.98 | [illegible] | -5.92 | 4570 | [illegible] |
| 8 | 1196 | 4440 -3.6 | -6.85 | 3990 | -4.00 | [illegible] | -5.48 | 4410 | -5.97 | [illegible] | -5.72 | 4570 | [illegible] |
| 9 | 1197 | 4010 -3.6 | -6.53 | 3810 | -3.85 | 4090 | -5.46 | 4140 | -6.47 | 4150 | -6.43 | 4780 | [illegible] |



APPENDIX G

Cable 151 (4th Test)

| No. | Thermo | 0400 Ice Adj / Corr | Equiv | 0700 Ice Adj | Equiv | 1000 Ice Adj | Equiv | 1300 Ice Adj | Equiv | 1600 Ice Adj | Equiv | 1900 Ice Adj | Equiv |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1189 | 04930 -3.7 | -8.85 | 04450 | -7.95 | [illegible] | -8.25 | [illegible] | -6.99 | [illegible] | -6.91 | 05550 | -7.73 |
| 2 | 1190 | 4340 -3.6 | -5.73 | [illegible] | -6.64 | [illegible] | -4.28 | 4000 | -4.28 | 3390 | -4.24 | 5000 | -8.90 |
| 3 | 1191 | 4500 -3.6 | -6.38 | [illegible] | -6.41 | [illegible] | -4.47 | [illegible] | -4.67 | [illegible] | -4.52 | 5100 | -8.50 |
| 4 | 1192 | 4010 -3.6 | -5.93 | [illegible] | -5.50 | [illegible] | -4.56 | [illegible] | -4.68 | [illegible] | -4.56 | [illegible] | -8.60 |
| 5 | 1193 | 4000 -3.7 | -6.12 | [illegible] | -6.85 | [illegible] | -4.57 | [illegible] | -4.32 | [illegible] | -4.89 | [illegible] | -8.11 |
| 6 | 1194 | 4500 -3.5 | -5.97 | [illegible] | -5.29 | [illegible] | -4.19 | [illegible] | -4.79 | [illegible] | -4.79 | [illegible] | -8.85 |
| 7 | 1195 | 4400 -3.6 | -5.77 | [illegible] | -5.98 | [illegible] | -4.47 | [illegible] | -5.22 | [illegible] | -4.14 | 5100 | -8.21 |
| 8 | 1196 | 4310 -3.6 | -6.07 | 4500 | -6.29 | [illegible] | -5.12 | [illegible] | -6.61 | [illegible] | -6.52 | 5100 | -8.83 |
| 9 | 1197 | 4330 -3.6 | -6.79 | 4300 | -6.69 | [illegible] | -4.74 | [illegible] | -5.34 | [illegible] | -6.25 | 5300 | -8.78 |

| No. | Thermo | 2200 | Equiv | 0100 | Equiv | 0400 | Equiv | 0700 | Equiv | 1000 | Equiv | 1300 | Equiv |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1189 | 04560 -3.7 | -7.27 | 05000 | -8.17 | [illegible] | -8.59 | 04150 | -8.29 | 04150 | -4.33 | 04710 | -7.97 |
| 2 | 1190 | 5100 -3.6 | -9.15 | 4350 | -5.79 | [illegible] | -6.73 | [illegible] | -5.55 | 4100 | -4.64 | 4000 | -4.25 |
| 3 | 1191 | 5000 -3.6 | 8.88 | [illegible] | -5.80 | [illegible] | -8.88 | [illegible] | -5.78 | 4010 | -5.84 | [illegible] | -8.02 |
| 4 | 1192 | 5110 -3.6 | -8.0[illegible] | 4500 | -6.30 | [illegible] | -8.68 | [illegible] | -5.89 | 4010 | -5.23 | 4150 | -4.25 |
| 5 | 1193 | 4960 -3.7 | -6.33 | [illegible] | -6.12 | [illegible] | -8.26 | [illegible] | -5.69 | 4310 | -5.78 | 4090 | -4.75 |
| 6 | 1194 | 4710 -3.5 | -8.06 | [illegible] | -6.38 | [illegible] | -7.47 | [illegible] | -6.74 | 4160 | -6.14 | [illegible] | -5.99 |
| 7 | 1195 | 5100 -3.6 | -8.19 | [illegible] | -6.18 | [illegible] | -5.01 | [illegible] | -5.49 | [illegible] | -5.49 | [illegible] | -9.74 |
| 8 | 1196 | 5000 -3.6 | -8.26 | [illegible] | -6.56 | [illegible] | -4.60 | [illegible] | -6.34 | 4510 | -6.28 | 4350 | -5.01 |
| 9 | 1197 | 4750 -3.6 | -7.96 | [illegible] | -6.49 | [illegible] | -6.38 | [illegible] | -4.78 | [illegible] | -5.70 | 3930 | -4.71 |

| No. | Thermo | 1600 | Equiv | 1900 PST | Equiv | 0100 | Equiv | 0400 | Equiv | 0700 | Equiv | 1000 PST | Equiv |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1189 | 04800 -3.7 | -8.22 | 04900 | -8.59 | 05000 | -8.77 | 05100 | -9.33 | 05109 | -9.68 | 05330 | -9.78 |
| 2 | 1190 | 4700 -3.6 | -7.37 | 5810 | -11.16 | 5600 | -10.49 | | | 5600 | -10.86 | 5730 | -10.00 |
| 3 | 1191 | 4860 -3.6 | -7.69 | 5700 | -10.61 | 5560 | -10.16 | 05540 | -10.08 | 5800 | -11.06 | 5900 | -11.33 |
| 4 | 1192 | 4810 -3.6 | -7.61 | 5670 | -10.80 | 5690 | -10.65 | 5350 | -10.93 | 5810 | -11.17 | 5900 | -11.32 |
| 5 | 1193 | 4730 -3.7 | -7.46 | 5540 | -10.42 | 5000 | -10.02 | 5100 | -11.00 | 5680 | -10.80 | 5700 | -11.00 |
| 6 | 1194 | 4700 -3.5 | -7.79 | 5350 | -10.20 | 5310 | -10.05 | 5500 | -10.65 | 5540 | -10.79 | 5650 | -11.14 |
| 7 | 1195 | 4910 -3.6 | -7.47 | 5710 | -10.22 | 5050 | -10.05 | 5650 | -10.00 | 5770 | -10.48 | 5700 | -10.60 |
| 8 | 1196 | 5000 -3.6 | -8.17 | 5540 | -10.51 | 5650 | -10.85 | 5710 | -10.64 | 5840 | -10.98 | 5930 | -11.2[illegible] |
| 9 | 1197 | 4630 -3.6 | -7.60 | 5360 | -10.60 | 5340 | -10.60 | 5590 | -10.3[illegible] | 5410 | -10.30 | 5650 | -11.16 |

| No. | Thermo | 1300 | Equiv |
|---|---|---|---|
| 1 | 1189 | 05300 -3.7 | -10.03 |
| 2 | 1190 | 5430 -3.6 | -9.85 |
| 3 | 1191 | 5500 -3.6 | -10.4[illegible] |
| 4 | 1192 | 5590 -3.6 | -10.8[illegible] |
| 5 | 1193 | 5450 -3.7 | -10.[illegible] |
| 6 | 1194 | 5410 -3.5 | -10.5[illegible] |
| 7 | 1195 | 5660 -3.6 | [illegible] |
| 8 | 1196 | 5610 -3.6 | [illegible] |
| 9 | 1197 | 5310 -3.6 | -9.[illegible] |

## APPENDIX H

### Density and Hardness Profiles, Camp 10B

I. Early February Density Values (400 cc. volume). Pit A, 7 Feb. 1951

| Reference Level (in.) | | Density (Av. 2-6 cores) |
|---|---|---|
| 118 | | ---- |
| 112 | | .203 |
| 106 | | .327* |
| 100 | | .301 |
| 94 | | .352 |
| 88 | | .373 |
| 82 | | .376* |
| 76 | | .358 |
| 70 | | .370 |
| 64 | | .398 |
| 58 | | .408 |
| 52 | | .417 |
| 46 | | .478* |
| 40 | | .576 |
| 34 | | .395 |
| 28 | | .560* |
| 22 | | .362 |
| 16 | | .322 |
| 10 | | .444 |
| 4 | | .411 |
| 0 | Firn Surface 1950 | .473* |
| -3 | | .624 |

*Values are considered to be questionable either due to the fact that only two samples were obtained or that the layer characteristics were such as to make accurate sampling at these horizons difficult. For this reason, most of these values were not plotted in Fig. 4.

Pit A. 10 February 1951.

| Reference Level (in.) | | Hole No. | Density: Sample 1 | Density: Sample 2 | Density: Average |
|---|---|---|---|---|---|
| 123 | | - | ---- | ---- | ---- |
| 112 | | 1 | .225 | .226 | .226 |
| 108 | | 2 | .287 | .293 | .290 |
| 104 | | 3 | .320 | .313 | .316 |
| 100 | | 4 | .292 | .293 | .293 |
| 96 | | 5 | .334 | .327 | .331 |
| 92 | | 6 | .320 | .318 | .319 |
| 88 | | 7 | .368 | .358 | .363 |
| 84 | | 8 | .341 | .337 | .339 |
| 80 | | 9 | .376 | .374 | .375 |
| 76 | | 10 | .361 | .353 | .357 |
| 72 | | 11 | .359 | .364 | .361 |
| 68 | | 12 | .373 | .378 | .375 |
| 63 | | 13 | .382 | .387 | .385 |
| 58 | | 14 | .408 | .407 | .408 |
| 54 | | 15 | .416 | .411 | .414 |
| 50 | | 16 | .432 | .435 | .434 |
| 46 | | 17 | .532 | .527 | .530 |
| 42 | | 18 | .549 | .529 | .549 |
| 38 | | 19 | .511 | .506 | .509 |
| 34 | | 20 | .415 | .415 | .415 |
| 30 | | 21 | .471 | .452 | .462 |
| 26 | | 22 | .424 | .423 | .424 |
| 22 | | 23 | .467 | .472 | .470 |
| 18 | | 24 | .449 | .452 | .451 |
| 14 | | 25 | .481 | .477 | .479 |
| 10 | | 26 | .494 | .489 | .492 |
| 9 | | 26 | .494 | .456 | .475 |
| 7 | | 27 | .384 | .434 | .399 |
| 5 | 1950 | 28 | .434 | .428 | .431 |
| 2 | Firn Surface | 29 | .458 | .472 | .465 |
| -4 | | 30 | .900 | .624 | .762 |

APPENDIX H. (Continued)

II. Late February Density and Hardness Values, Pit A.

| Reference Level Above 1950 Firn (in.) | Sampling Levels* | Density (19 Feb.) (Av. 2-6 cores) | Hardness (21 Feb.) (10-15 samples) (gm/cm$^2$) |
|---|---|---|---|
| 150 | surface | ---- | surface |
| 149 | | | 4 |
| 148 | | | 15 |
| 147 | | | 22 |
| 146 | new snow | ---- | 40 |
| 145 | | | 53 |
| 144 | | | 22 |
| 143 | | | 25 |
| 142 | " " | .085 | 30 |
| 141 | | | 30 |
| 140 | | | 18-31 |
| 139 | | | 22-32 |
| 138 | " " | .139 | 22-38 |
| 136 | | | 32 |
| 134 | " " | .150 | 28-50 |
| 132 | | | 85-95 |
| 130 | " " | .142 | 85-200 |
| 128 | | | 175 |
| 126 | " " | .214 | 125-225 |
| 124 | | | 200-350 |
| 122 | " " | .211 | 200-400 |
| 120 | | | 225-400 |
| 118 | " " | .238 | 275-475 |
| 116 | | | 200-475 |
| 114 | " " | .231 | 275-975 |
| 110 | ---- | .269 | 400-900 |
| 106 | ---- | .299 | 400-900 |
| 104 | Opp. Wand 1 | .306 | |
| 102 | Opp. D.H. 2 | .348 | 500-1000 |
| 98 | Opp. D.H. 3 | .365 | 600-950 |
| 94 | Opp. D.H. 4 | .356 | |

(cont. next page)

*Location of these density levels is in reference to density holes noted in February 10 profile. Also see stratigraphic Table, Section 2 (c) of this report

**"Schwimm Schnee" of September 1950 (depth hoar stratum)

| Reference Level Above 1950 Firn (in.) | Sampling Levels | Density (19 Feb.) (Av. 2-6 cores) | Hardness (21 Feb.) (10-15 samples) (gm/cm²) |
|---|---|---|---|
| 92 | ---- | ---- | 500-1000 |
| 90 | Opp. DH 5 | .378 | 850-1200 |
| 86 | 1" Bel. DH 6 | .366 | 900-1300 |
| 82 | 1" Bel. DH 7, W 3 | .355 | 900-2500 |
| 78 | 1½" Bel. DH 8 | .385 | 2000-4000 |
| 74 | 2" Bel. DH 9 | .405 | 3000-4000 |
| 70 | 2" Bel. DH 10 | .377 | 2800-3600 |
| 66 | 2" Bel. DH 11 | .382 | 4500-5500 |
| 62 | 2¼" Bel. DH 12 | .424 | 4800-5800 |
| 58 | 1½" Bel. DH 13, W4 | .398 | 3800-5200 |
| 54 | 1" Bel. DH 14 | .409 | 7500-8500 |
| 50 | 1" Bel. DH 15 | .433 | 5000-7500 |
| 46 | Opp. DH 16 | .433 | 3000-4400 |
| 44 | ---- | ---- | Diff. to determine |
| 42 | 1½" Bel. DH 17 | .511 | Too hard (40-42") |
| 38 | 1"Bel. DH 18 | .557 | --------- |
| 36 | ---- | ---- | 4000-5000 |
| 34 | 1" Bel. DH 19 | .455 | --------- |
| 30 | 2" Bel. DH 20, W5 | .414 | 5000-8500 |
| 28 | 3" Bel. DH 20 | .457 | --------- |
| 26 | ½" Bel. DH 21 | .457 | --------- |
| 24 | ---- | ---- | 5000-6500 |
| 22 | Opp. DH 22 | .473 | --------- |
| 18 | Opp. DH 23 | .463 | 3500-4000 |
| 14 | Opp. DH 24 | .458 | --------- |
| 12 | ---- | ---- | 6800-7400 |
| 10 | Opp. DH 25 | .479 | --------- |
| 6 | Opp. DH 26 | .418 | 3000-5500* |
| 2 | Opp. DH 27 | .397 | --------- |
| 0 | On 1950 firn surface wand 6 | .441 | 4000 (depth hoar, Sept.'50) |

*"Schwimm Schnee" of September 1950

## APPENDIX I

### Thermistor Characteristics

Thermistor Cables No. 148 and No. 149

| Selector Switch Position | Lead Resistance* | Thermistor Numbers Cable 148** | Cable 149*** | Depth Below Zero (ft.) |
|---|---|---|---|---|
| 1 | 0.870 | 1098 | 1117 | 0 |
| 2 | 0.875 | 1099 | 1119 | 1 |
| 3 | 0.881 | 1100 | 1120 | 2 |
| 4 | 0.880 | 1101 | 1121 | 3 |
| 5 | 0.876 | 1102 | 1122 | 4 |
| 6 | 0.883 | 1103 | 1123 | 5 |
| 7 | 0.868 | 1104 | 1124 | 6 |
| 8 | 0.880 | 1105 | 1125 | 7 |
| 9 | 0.868 | 1106 | 1126 | 8 |
| 10 | 0.882 | 1255 | 1127 | 9 |
| 11 | 0.870 | 1108 | 1128 | 10 |
| 12 | 0.859 | 1109 | 1129 | 12.5 |
| 13 | 0.875 | 1110 | 1130 | 15 |
| 14 | 0.876 | 1111 | 1131 | 17.5 |
| 15 | 0.876 | 1112 | 1132 | 20 |
| 16 | 0.886 | 1113 | 1133 | 22.5 |
| 17 | 0.870 | 1114 | 1134 | 25 |
| 18 | 0.872 | 1115 | 1135 | 30 |
| 19 | 0.865 | 1116 | 1136 | 35 |

Thermistor Cable No. 150 (formerly inserted in crevasse at 10B in 1950-51 period. Apparently an extra thermistor at the present time.) Total length of cable, 50 feet.

| Selector Switch Position | Lead Resistance* | Thermistor Number | Depth Below Zero (ft.) |
|---|---|---|---|
| 1 | 3.690 | 1179 | 5 |
| 2 | 3.604 | 1180 | 10 |
| 3 | 3.590 | 1181 | 15 |
| 4 | 3.619 | 1182 | 20 |
| 5 | 3.665 | 1183 | 25 |
| 6 | 3.539 | 1184 | 30 |
| 7 | 3.637 | 1185 | 35 |
| 8 | 3.617 | 1186 | 40 |
| 9 | 3.588 | 1187 | 50 |

*Resistance of each circuit minus thermistor resistance in OHMS at room temperature.

**Inserted below drill platform at Camp 10B to depth of 12 feet, total length of cable, 35 feet.

***Total length of cable, 35 feet.

Thermistor Cable No. 151 (extra cable) total length of cable, 50 feet.

| Selector Switch Pos. | Lead Resist.* | Thermistor No. | Depth Below Zero (ft.) |
|---|---|---|---|
| 1 | 3.651 | 1189 | 5 |
| 2 | 3.581 | 1190 | 10 |
| 3 | 3.587 | 1191 | 15 |
| 4 | 3.602 | 1192 | 20 |
| 5 | 3.660 | 1193 | 25 |
| 6 | 3.525 | 1194 | 30 |
| 7 | 3.610 | 1195 | 35 |
| 8 | 3.640 | 1196 | 40 |
| 9 | 3.628 | 1197 | 50 |

Thermistor Cable No. 152 (inserted in ice ~~160~~ 170 feet) length of cable, 200 feet.

| Selector Switch Pos. | Lead Resist.* | Thermistor No. | Depth Below Zero (ft.) |
|---|---|---|---|
| 1 | 4.567 | 1237 | 10 |
| 2 | 4.526 | 1238 | 20 |
| 3 | 4.564 | 1239 | 30 |
| 4 | 4.566 | 1240 | 40 |
| 5 | 4.695 | 1241 | 50 |
| 6 | 4.614 | 1242 | 60 |
| 7 | 4.558 | 1243 | 70 |
| 8 | 4.701 | 1244 | 80 |
| 9 | 4.724 | 1245 | 90 |
| 10 | 4.512 | 1246 | 100 |
| 11 | 4.529 | 1247 | 110 |
| 12 | 4.475 | 1248 | 120 |
| 13 | 4.644 | 1249 | 130 |
| 14 | 4.613 | 1250 | 140 |
| 15 | 4.586 | 1251 | 150 |
| 16 | 4.559 | 1252 | 160 |
| 17 | 4.687 | 1253 | 180 |
| 18 | 4.670 | 1254 | 200 |
| Test | 4.600 | ---- | --- |

Thermistor Cable No. 153 total length of cable, 400 feet.

| Selector Switch Pos. | Lead Resist.* | Thermistor No. | Depth Below Zero (ft.) |
|---|---|---|---|
| 1 | 8.928 | 1173 | 20 |
| 2 | 8.835 | 1174 | 40 |
| 3 | 8.923 | 1175 | 60 |
| 4 | 8.921 | 1176 | 80 |
| 5 | 9.174 | 1177 | 100 |
| 6 | 9.027 | 1178 | 120 |
| 7 | 8.903 | 1224 | 140 |
| 8 | 9.183 | 1225 | 160 |
| 9 | 9.213 | 1226 | 180 |
| 10 | 8.804 | 1228 | 200 |
| 11 | 8.833 | 1229 | 225 |
| 12 | 8.722 | 1230 | 250 |
| 13 | 9.086 | 1231 | 275 |
| 14 | 9.058 | 1232 | 300 |
| 15 | 8.941 | 1233 | 325 |
| 16 | 8.910 | 1234 | 350 |
| 17 | 9.155 | 1235 | 375 |
| 18 | 9.102 | 1236 | 400 |
| Test | 9.002 | ---- | --- |

# APPENDIX J

Cell 148

SOME VALUES SHOWN TO BE REQUIRE A FACTOR OF 10.
IN THESE CALCULATIONS THE FACTOR 10 IS APPLIED TO ALL RESISTANCE READINGS

| Sw. No. | Tap No. | Breaking 3/18 ?:?? PM Res. | Equiv. | 3/19 ?:?? Res. | Equiv. | 3/19 11 AM Res. | Equiv. | 3/19 7:00 PST Res. | Equiv. | 3/19 ?? PM Res. | Equiv. | 3/20 10 AM Res. | Equiv. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | [illegible] | [illegible] -0.9 | -13.?? | [illegible] | -2.16 | [illegible] | -9.1? | 5?11 | -?.33 | 5?10 | -13.3? | 05?0 | [illegible] |
| 2 | [illegible] | [illegible] -0.9 | -1?.?? | 5??0 | -9.38 | 5?00 | -9.?? | 5?9? | -?.97 | 5??0 | -9.9? | 5?9? | [illegible] |
| 3 | [illegible] | [illegible] -0.9 | [illegible] | 5??0 | -10.50 | 5?30 | -9.?? | 5?6? | -?.65 | 5?60 | -9.6? | 5?00 | [illegible] |
| 4 | [illegible] | [illegible] -0.9 | [illegible] | 5??0 | -11.?? | 5?90 | -1?.?? | 5?7? | -10.17 | 5?40 | -10.1? | 5?40 | [illegible] |
| 5 | [illegible] | [illegible] -0.9 | [illegible] | [illegible] | -1?.?? | 5?50 | [illegible] | 5?10 | [illegible] | 5?10 | [illegible] | 5?90 | [illegible] |
| 6 | [illegible] | [illegible] -0.9 | [illegible] | [illegible] | -1?.?? | 5?10 | -10.4? | 5?9? | -?.91 | 5?10 | -10.8? | 5?90 | [illegible] |
| 7 | [illegible] | [illegible] -0.9 | [illegible] | [illegible] | -11.?? | [illegible] | -10.?? | [illegible] | -?.35 | [illegible] | [illegible] | 5?90 | [illegible] |
| 8 | [illegible] | ?180 -0.9 | [illegible] | 5??0 | -11.27 | 5?90 | -10.?? | 55?0 | -?.?? | 5?10 | [illegible] | 5?50 | [illegible] |
| 9 | [illegible] | 5?00 -0.9 | [illegible] | 5??0 | -10.?? | 5?40 | -10.?? | 55?0 | -?.?? | 5?40 | [illegible] | 5?70 | [illegible] |
| 10 | [illegible] | 5?00 -0.9 | [illegible] | 5??0 | -10.?? | 5?40 | -9.?? | 5?40 | [illegible] | 5?40 | -9.?? | 5?10 | [illegible] |
| 11 | [illegible] | 5?00 -0.9 | [illegible] | 5?30 | -10.?? | 55?0 | -10.06 | 5?50 | -9.97 | 5?60 | -9.77 | 5?40 | -9.92 |
| 12 | [illegible] | ?7?0 -0.9 | [illegible] | [illegible] | -11.93 | 5510 | -10.39 | 5?10 | -?.?? | 5?00 | -10.03 | 5?40 | -?.?7 |
| 13 | [illegible] | ??5?0 -0.9 | [illegible] | 5??0 | [illegible] | 5?50 | -2.?? | 5?40 | -?.74 | 5?00 | -8.57 | 5?10 | [illegible] |
| 14 | [illegible] | ??0?0 -0.9 | [illegible] | 5?0 | [illegible] | 5?10 | -9.77 | 5?10 | -9.63 | 5?10 | -9.?? | 5?10 | [illegible] |
| 15 | [illegible] | 5?10 -0.9 | -10.?0 | [illegible] | [illegible] | 5?40 | [illegible] | 5?40 | [illegible] | 5?10 | [illegible] | 5?10 | [illegible] |
| 16 | [illegible] | ?920 -0.9 | [illegible] | 5?50 | -?.?? | 4?40 | -8.?? | 4?50 | -7.02 | 4?10 | -8.03 | 4?40 | -?.?? |
| 17 | [illegible] | ?0?0 -0.9 | [illegible] | ?9?0 | -6.?? | 4?10 | -6.70 | 4?40 | -5.79 | 4?10 | -8.51 | 4?40 | -4.77 |
| 18 | [illegible] | 3?90 -0.9 | [illegible] | 3?00 | -3.?? | 3?10 | -3.3? | 3?40 | -3.40 | 3?00 | -3.40 | 3?90 | -3.40 |
| 19 | [illegible] | -0.9 | | 3?60 | -2.04 | | | | | | | | |

| Sw. No. | Tap No. | Breaking 3/?? ?? PM Res. | Equiv. | 3/?? ?:?? PST Res. | Equiv. | 3/?? 11:00 AM Res. | Equiv. | 3/?? 7?? Res. | Equiv. | 3/?? ?? Res. | Equiv. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1098 | 05?90 -0.9 | -8.5? | 05?10 | +8.58 | 05?10 | -3.?? | 05??0 | +8.76 | 0?60 | -9.1? |
| 2 | 1099 | 05?90 -0.9 | -9.?? | 5??0 | +9.18 | 5??0 | -9.1? | 5??0 | +9.18 | ?100 | +8.7? |
| 3 | 1100 | 5390 -0.9 | -9.5? | 5??0 | +9.50 | 5??0 | -9.5? | 5??0 | -9.51 | ?330 | -9.50 |
| 4 | 1101 | 5340 -0.9 | -10.01 | 53?0 | +10.01 | 5??0 | -9.96 | 5?90 | -9.96 | ?390 | -10.2? |
| 5 | 1102 | 5670 -0.9 | -10.26 | 5?5? | +10.19 | 5??0 | -10.13 | 5??0 | -10.07 | ?5?? | [illegible] |
| 6 | 1103 | 5910 -0.9 | -10.22 | 5?90 | +10.18 | 5?? | -10.?? | 5??0 | -10.09 | | |
| 7 | 1104 | 5950 -0.9 | -10.20 | 5?50 | +10.20 | 5?40 | -10.01 | 5??0 | -10.0? | ?400 | -?.10 |
| 8 | 1105 | 5550 -0.9 | -10.21 | 55?0 | +10.19 | 55?0 | -10.0? | 55?0 | +10.0? | ?550 | -10.21 |
| 9 | 1106 | 5950 -0.9 | -9.97 | 5?50 | -9.97 | 5?50 | -9.97 | 5?50 | -9.9? | ?9?0 | -9.85 |
| 10 | 1107 | 5?60 -0.9 | -9.79 | 5?40 | -9.79 | 5?40 | -9.79 | 5?40 | -9.7? | ?9?0 | -9.85 |
| 11 | 1108 | 5450 -0.9 | -9.99 | 5?50 | -9.99 | 5??0 | -9.92 | 5?40 | -9.9? | ?500 | -10.0? |
| 12 | 1109 | 5550 -0.9 | -9.86 | 5?40 | -9.92 | 55?0 | -10.65 | 5?00 | +10.05 | ?5?0 | -10.39 |
| 13 | 1110 | 5000 -0.9 | -9.71 | 5?90 | -2.00 | 5??0 | -10.60 | 5510 | -10.21 | ?150 | -9.85 |
| 14 | 1111 | 5540 -0.9 | -10.90 | 5810 | +10.78 | 5??0 | -10.8? | 5380 | -10.77 | ?410 | -9.77 |
| 15 | 1112 | 5430 -0.9 | -10.6? | 5?40 | -10.6? | 5?54 | -10.6? | 5?40 | -10.6? | ?540 | -10.87 |
| 16 | 1113 | 4140 -0.9 | -7.8? | 4?40 | -7.80 | 4?1? | -7.82 | 4??? | -7.78 | ?9?0 | -8.45 |
| 17 | 11?4 | 4340 -0.9 | -5.7? | 4?10 | -6.70 | 4?10 | -5.70 | 4?10 | -5.70 | 4310 | -6.70 |
| 18 | 1115 | 3840 -0.9 | -3.40 | 3850 | -3.40 | 3850 | -3.00 | 3850 | -3.40 | 3830 | -3.35 |
| 19 | 1116 | -0.9 | | | | | | 3570 | -2.0? | | |



# APPENDIX J

Cell 150

| Sw. No. | Tap No. | Breaking 3/19 3:?? ?? Res. | Equiv. | ?? Res. | Equiv. | 3/19 5:?? PM Res. | Equiv. | ?? Res. | Equiv. | 3/19 7:15 PM Res. | Equiv. | 3/20 ?? AM Res. | Equiv. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1179 | 11?50 -33 | -10.8? | [illegible] | -10.99 | ?5?? | -10.9? | ?10?? | -10.99 | 0?570 | -13.81 | 05?30 | [illegible] |
| 2 | 11?0 | 11090 -36 | -11.76 | [illegible] | -11.79 | 1??90 | -11.76 | [illegible] | -11.79 | 0?570 | -16.12 | 5?60 | [illegible] |
| 3 | 11?1 | 4660 -36 | -6.86 | 4660 | -6.86 | 4?64 | -6.86 | ?6?0 | -6.86 | ?66? | -6.09 | 4?60 | +6.0? |
| 4 | 11?2 | 3560 -36 | -1.81 | 35?0 | -1.80 | 35?0 | -1.81 | 35?0 | -1.86 | 35?0 | -1.91 | 3?00 | -2.0? |
| 5 | 11?3 | 3??0 -33 | -0.47 | 3??0 | -0.47 | 3??0 | -0.47 | 3??0 | -0.47 | 3??0 | -0.47 | 3?40 | [illegible] |
| 6 | 11?4 | 3150 -35 | -0.26 | 3?40 | -0.26 | 3150 | -0.26 | 3?46 | -0.26 | 3?60 | -0.26 | 3?50 | [illegible] |
| 7 | 11?5 | 3060 -36 | -0.03 | 3?70 | -0.03 | 3?60 | -0.03 | 3?70 | -0.08 | 3?60 | -0.03 | 3?60 | [illegible] |
| 8 | 11?6 | 3170 -36 | -0.07 | 3170 | -0.07 | 3170 | -0.09 | [illegible] | -0.07 | 3170 | -0.09 | 3?60 | -0.09 |
| 9 | 11?7 | 3490 -36 | -0.11 | 3?80 | -0.11 | 3?80 | -0.11 | 3?80 | -0.11 | 3?80 | -0.11 | 3?80 | -0.11 |

| Sw. No. | Tap No. | 3/19 11:30 PST Res. | Equiv. | 3/19 9:30 PM Res. | Equiv. | 3/20 ?? am Res. | Equiv. | 3/20 11:?? pm Res. | Equiv. | 3/20 ?:00 PST Res. | Equiv. | 3/20 ?? Res. | Equiv. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1178 | 05640 -33 | -10.15 | 05640 | +10.07 | 0555? | -9.91 | 05540 | -9.88 | 05510 | [illegible] | 0?460 | [illegible] |
| 2 | 11?0 | 5680 -36 | -10.27 | 5??0 | +10.29 | 5?30 | -10.11 | 5580 | +9.69 | 5?00 | -10.0? | 5?60 | [illegible] |
| 3 | 11?1 | 4410 -36 | -6.12 | 4??0 | +6.16 | 4??0 | -6.16 | 4410 | +6.16 | 4?10 | -6.0? | 4??0 | [illegible] |
| 4 | 11?2 | 3600 -36 | -2.02 | 3600 | +2.02 | 3??0 | -2.02 | 3600 | -2.02 | 3?10 | -2.02 | 3?40 | [illegible] |
| 5 | 11?3 | 3?00 -33 | -0.47 | 3?00 | +0.47 | [illegible] | -0.4? | 3?00 | -0.23 | 3?30 | -0.41 | 3?40 | [illegible] |
| 6 | 11?4 | 3160 -35 | -0.26 | 3160 | +0.26 | 3?60 | -0.26 | 3150 | -0.26 | 3?50 | -0.26 | 3?60 | [illegible] |
| 7 | 11?5 | 3060 -36 | -0.032 | 3070 | +0.08 | [illegible] | -0.08 | 3060 | -0.08 | 3?70 | -0.37 | [illegible] | [illegible] |
| 8 | 11?6 | 3170 -36 | -0.07 | 3170 | +0.07 | 3?70 | -0.07 | 3170 | -0.07 | 3?60 | [illegible] | 3?0 | [illegible] |
| 9 | 11?7 | 3480 -36 | -0.11 | 3?80 | +0.11 | 3?50 | -0.11 | 3490 → | +0.34 | 3?10 | [illegible] | 3?90 | [illegible] |

| Sw. No. | Tap No. | 3/20 1930 Res. | Equiv. | 3/?? 9:30 ?? Res. | Equiv. | 3/?? 1 — Res. | Equiv. | Res. | Equiv. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | [illegible] | 05?90 -33 | -10.?? | 05?40 | -9.19 | 05?9? | -9.?? | 0?130 | [illegible] |
| 2 | [illegible] | 5550 -33 | [illegible] | 55?0 | [illegible] | 55?0 | -9.13 | 5?60 | [illegible] |
| 3 | [illegible] | 4410 -36 | -6.0? | 4?00 | -6.?? | 4??0 | -6.12 | ?6?0 | [illegible] |
| 4 | [illegible] | 3600 -36 | -2.0? | 3?10 | -2.0? | 35?0 | -1.97 | ?600 | [illegible] |
| 5 | [illegible] | 3400 -33 | -0.4? | 3?40 | -0.4? | 3?00 | -0.47 | ?400 | [illegible] |
| 6 | [illegible] | 3160 -33 | -0.2? | 3160 | +0.26 | 3?10 | -0.32 | ?150 | [illegible] |
| 7 | [illegible] | 3000 -36 | -0.0? | 3?70 | +0.08 | 3?10 | -0.08 | ?000 | [illegible] |
| 8 | [illegible] | 3?20 -36 | -0.0? | 3?70 | +0.07 | 3?10 | -0.07 | ?160 | [illegible] |
| 9 | [illegible] | 3??0 -36 | [illegible] | 3?80 | -0.11 | 3?80 | -0.11 | ?380 | [illegible] |

S-7-7

# APPENDIX J

Cable 152

| Sensor | Tower | 5/9 PM 104 ADJ | Equiv % | 5/14 104 ADJ | Equiv % | 5/15 1000 PST 104 ADJ | Equiv % | 5/17 1000 PST 104 ADJ | Equiv % | 5/18 11 AM 104 ADJ | Equiv % | 5/19 1730 PST 104 ADJ | Equiv % | 5/19 10 PM 104 ADJ | Equiv % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1537 | 10000 | -23.00 | 05560 | -9.38 | 05450 | -3.59 | 04980 | -[illegible] | 05000 | -8.07 | 05000 | -8.02 | 05150 | -8.66 |
| 2 | 1538 | 07000 | -15.77 | 5460 | -10.02 | 5590 | -10.88 | 5570 | -[illegible] | 5300 | -10.89 | 5380 | -10.15 | 5360 | -10.47 |
| 3 | 1539 | 6600 | -13.8[illegible] | 5700 | -11.06 | 5690 | -11.08 | 5650 | -12.05 | 5930 | -10.1[illegible] | 5380 | -10.8[illegible] | 5180 | -10.[illegible] |
| 4 | 1540 | 5090 | -8.59 | 5350 | -9.97 | 5310 | -9.86 | 5300 | -9.8[illegible] | 5[illegible] | -9.8[illegible] | 5370 | -9.71 | 5370 | -9.91 |
| 5 | 1541 | 3900 | -3.69 | 3950 | -3.69 | 3450 | -3.69 | 3[illegible] | -3.8[illegible] | 4000 | -3.9[illegible] | 4000 | -3.9[illegible] | 4010 | -[illegible] |
| 6 | 1542 | 3350 | -1.52 | 3380 | -1.57 | 3390 | -1.58 | 3390 | -1.59 | [illegible] | -1.00 | 3400 | -1.64 | 3000 | -1.0[illegible] |
| 7 | 1543 | 3310 | -0.51 | 3300 | -0.57 | 3300 | -0.57 | 3300 | -0.57 | 3330 | -0.61 | 3330 | -0.65 | 3330 | -0.[illegible] |
| 8 | 1544 | 3160 | -0.16 | 3170 | -0.2[illegible] | 3180 | -0.48 | 3170 | -0.22 | 3170 | -0.22 | 3170 | -0.22 | 3170 | -0.22 |
| 9 | 1545 | 3000 | -0.05 | 3000 | -0.05 | 3000 | -0.17 | 3000 | -0.09 | 3000 | -0.0[illegible] | 3000 | -0.05 | 3000 | -0.0[illegible] |
| 10 | 1546 | 3130 | -0.02 | 3100 | +0.00 | 3130 | -3.02 | 3130 | -0.02 | 3[illegible] | -0.02 | 3130 | -0.02 | 3130 | -0.02 |
| 11 | 1547 | 3180 | -0.17 | 3180 | -0.17 | 3180 | -0.17 | 3170 | -0.17 | 3180 | -0.17 | 3180 | -0.17 | 3180 | -0.17 |
| 12 | 1548 | 3050 | -0.06 | 3090 | +0.0[illegible] | 3050 | -0.06 | 3[illegible] | +0.01 | 3050 | -0.05 | 3050 | -0.05 | 3050 | -0.0[illegible] |
| 13 | 15[illegible] | 3010 | -0.20 | 3000 | -0.1[illegible] | 3010 | -0.34 | 3010 | -0.24 | 3010 | -0.34 | 3000 | -0.1[illegible] | 3010 | -0.[illegible] |
| 14 | [illegible] | 3000 | -0.06 | 3000 | -0.0[illegible] | 3000 | -0.06 | 3000 | -0.0[illegible] | 3000 | -0.0[illegible] | 3000 | -0.0[illegible] | 3190 | -0.0[illegible] |
| 15 | [illegible] | 3190 | -0.0[illegible] | 3150 | -0.0[illegible] | 3150 | -0.0[illegible] | 3150 | -0.0[illegible] | 3190 | [illegible] | 3190 | [illegible] | 3100 | [illegible] |
| 16 | 1560 | 3000 | -0.0[illegible] | 3000 | -0.0[illegible] | 3330 | -0.0[illegible] | 3330 | -0.02 | 3030 | -0.02 | 3340 | +0.0[illegible] | 3030 | -0.0[illegible] |
| 17 | 1563 | 3000 | -1.62 | 3330 | -0.0[illegible] | 3330 | -0.05 | 3330 | -0.3[illegible] | 3330 | -0.0[illegible] | 3330 | -0.0[illegible] | 3330 | -0.0[illegible] |
| 18 | 1564 | 3190 | -0.2[illegible] | 3190 | -0.23 | 3190 | -0.23 | 3190 | -0.2[illegible] | 3180 | -0.1[illegible] | 3190 | -0.23 | 3190 | -0.2[illegible] |
| 19 | | | | | | | | | | | | | | | |

| Sensor | Tower | 5/20 10 AM 104 ADJ | Equiv % | 5/20 [illegible] 104 ADJ | Equiv % | 5/21 1000 PST 104 ADJ | Equiv % | 5/21 11 AM 104 ADJ | Equiv % | 5/21 1800 104 ADJ | Equiv % | 5/24 4 PM 104 ADJ | Equiv % | [illegible] 11 AM 104 ADJ | Equiv % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1537 | 05920 | -8.62 | 05500 | -8.72 | 05390 | -8.87 | 05350 | -9.28 | 05000 | -9.0[illegible] | 05530 | -9.20 | 05000 | -9.69 |
| 2 | 1538 | 5900 | -[illegible] | 5380 | -[illegible] | 5300 | -9.90 | 5300 | -9.8[illegible] | 5300 | -9.8[illegible] | 5300 | -9.52 | 5360 | -10.0[illegible] |
| 3 | 1539 | 5350 | -[illegible] | 5350 | -[illegible] | 5000 | -[illegible] | 5500 | -10.0[illegible] | 5000 | -10.0[illegible] | 5190 | -[illegible] | 5040 | -10.[illegible] |
| 4 | 1540 | 5060 | -9.07 | 5060 | -9.07 | 5000 | -9.60 | 5000 | -9.6[illegible] | 5030 | -9.57 | 5190 | -9.2[illegible] | 5300 | -9.[illegible] |
| 5 | 1541 | 4000 | -4.03 | 4000 | -4.03 | 4010 | -3.77 | 4010 | -3.[illegible] | 4000 | -4.0[illegible] | 4000 | -4.0[illegible] | 4000 | -[illegible] |
| 6 | 1542 | 3090 | -1.69 | 4010 | -1.79 | 3390 | -1.58 | 3000 | -1.5[illegible] | 3900 | -1.69 | 3910 | -1.69 | 3000 | -1.6[illegible] |
| 7 | 1543 | 3330 | -0.6[illegible] | 3170 | +0.32 | 3330 | -0.63 | 3330 | -0.62 | 3330 | -0.63 | 3100 | -0.6[illegible] | 3330 | -0.6[illegible] |
| 8 | 1544 | 3170 | -0.22 | 3170 | -0.22 | 3170 | -0.22 | 3170 | -0.22 | 3180 | -0.1[illegible] | 3180 | -0.2[illegible] | 3170 | -0.2[illegible] |
| 9 | 1545 | 3000 | -0.0[illegible] | 3000 | -0.0[illegible] | 3000 | -0.05 | 3000 | -0.0[illegible] | 3030 | -0.11 | 3030 | -0.1[illegible] | 3000 | -0.0[illegible] |
| 10 | 1546 | 3000 | +0.00 | 3130 | -0.0[illegible] | 3000 | +0.04 | 3000 | +0.0[illegible] | 3130 | -0.02 | 3130 | -0.02 | 3130 | -0.0[illegible] |
| 11 | 1547 | 3170 | -0.11 | 3170 | -0.11 | 3170 | -0.11 | 3170 | -0.11 | 3180 | -0.11 | 3180 | -0.17 | 3180 | -0.1[illegible] |
| 12 | 1548 | 3000 | +0.01 | 3000 | +0.01 | 3000 | +0.01 | 3000 | +0.0[illegible] | 3050 | -0.05 | 3050 | -0.06 | 3050 | -0.0[illegible] |
| 13 | 1549 | 3000 | -0.1[illegible] | 3000 | -0.1[illegible] | 3000 | -0.1[illegible] | 3000 | -0.1[illegible] | 3010 | -0.2[illegible] | 3010 | -0.24 | 3010 | -0.2[illegible] |
| 14 | 1550 | 3190 | -0.0[illegible] | 3000 | -0.0[illegible] | 3190 | 0.0[illegible] | 3140 | 0.0[illegible] | 3000 | -0.1[illegible] | 3000 | -0.0[illegible] | 3000 | -0.0[illegible] |
| 15 | 1561 | 3100 | +0.00 | 3100 | +0.0[illegible] | 3100 | +0.00 | 3100 | +0.00 | 3150 | -0.0[illegible] | 3150 | -0.06 | 3140 | +0.0[illegible] |
| 16 | 1562 | 3030 | -0.02 | 3030 | -0.02 | 3030 | -0.0[illegible] | 3030 | -0.0[illegible] | 3000 | -0.0[illegible] | 3000 | -0.08 | 3030 | -0.0[illegible] |
| 17 | 1563 | 3330 | -0.0[illegible] | 3330 | -0.0[illegible] | 3330 | +0.21 | 3330 | -0.0[illegible] | 3330 | -0.05 | 3330 | -0.05 | 3330 | -0.0[illegible] |
| 18 | 1564 | 3190 | -0.12 | 3330 | -0.[illegible] | 3190 | -0.17 | 3180 | -0.1[illegible] | 3190 | -0.[illegible] | 3190 | -0.23 | 3180 | -0.1[illegible] |
| | | | | 3190 | | | | | | | | | | | |

APPENDIX K

Record of Aluminum Pipe Survey with Eastman Single Shot Survey Instrument

Camp 10B, upper Taku Glacier, August 22, 1950

| | Measured Depth* | Drift Angle | True Vertical Depth | Drift Direction | Course Deviation | Rectangular Coordinates S | W |
|---|---|---|---|---|---|---|---|
| 1 | 42 | 0°10' | Same as Measured Depth | S 55° W | 0 08 | 05 | 07 |
| 2 | 62 | 0°35' | | S 69° W | 0 20 | 12 | 26 |
| 3 | 82 | 0°35' | | S 86° W | 0 32 | 14 | 58 |
| 4 | 102 | 1°10' | | S 73° W | 0 41 | 26 | 97 |
| 5 | 122 | 1°00' | | S 74° W | 0 35 | 36 | 131 |
| 6 | 142 | 1°05' | | S 65° W | 0 38 | 52 | 165 |
| 7 | 162 | 1°00' | | S 72° W | 0 35 | 63 | 198 |
| 8 | 182 | 1°00' | | N 88° W | 0 35 | 62 | 233 |
| 9 | 202 | 1°05' | | S 53° W | 0 38 | 85 | 263 |
| 10 | 222 | 1°05' | | S 60° E | 0 38 | 104 | 230 |
| 11 | 242 | 1°05' | | S 65° E | 0 38 | 142 | 227 |
| 12 | 245** | 1°05' | | S 04° E | 06 | 148 | 227 |

Closure S 56° 54' W 2.71'

*From reference level on pipe 15 feet above drill platform, August 22, 1950; top 15 feet may be considered essentially vertical as far as August survey is concerned.

** Projected

APPENDIX L

Record of Aluminum Pipe Survey with Eastman Single Shot Survey Instrument

Camp 10B, upper Taku Glacier

Date: February 11, 1951

| | Measured Depth | Drift Angle | True Verticle Depth | Drift Direction | Course Deviation | Rectangular Coordinates S | E | W |
|---|---|---|---|---|---|---|---|---|
| 1 | 23 | 0°45' | 22 99 | S 87°00' E | 0 30 | 02 | 30 | |
| 2 | 43 | 0°25' | 42 99 | S 25°00' E | 0 15 | 16 | 36 | |
| 3 | 63 | 0°35' | 62 99 | S 57°00' W | 0 20 | 27 | 19 | |
| 4 | 83 | 1°45' | 82 99 | S 75°00' W | 0 61 | 43 | | 40 |
| 5 | 103 | 2°00' | 102 97 | S 45°00' W | 0 70 | 92 | | 69 |
| 6 | 115 | 1°45' | 114 96 | N 75°00' W | 0 37 | 82 | | 125 |
| 7 | 123 | 1°35' | 122 96 | N 87°00' W | 0 22 | 81 | | 147 |
| 8 | 143 | 0°50' | 142 96 | S 86°00' W | 0 29 | 83 | | 176 |
| 9 | 163 | 1°00' | 162 96 | S 84°00' W | 0 38 | 87 | | 214 |
| 10 | 183 | 1°05' | 182 96 | S 74°00' W | 0 38 | 97 | | 251 |
| 11 | 203 | 1°05' | 202 96 | N 21°00' E | 0 38 | 62 | | 237 |
| 12 | 215 | 0°55' | 214 96 | N 70°00' E | 0 19 | 56 | | 219 |
| 13 | 223 | 1°05' | 222 96 | S 10°00' W | 0 15 | 71 | | 222 |
| 14 | 239 | 1°25' | 238 96 | S 52°00' E | 0 40 | 96 | | 190 |
| 15 | 243 | 1°20' | 242 96 | S 46°00' E | 0 09 | 102 | | 184 |
| | | | Closure | S 61°00' W | 2 10' | | | |

Date: February 17, 1951

| | | | | | | N | S | E | W |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 18 | 0°25' | 18 00 | N 87°00' E | 0 13 | 01 | | 13 | |
| 2 | 55 | 0°15' | 55 00 | S 38°00' W | 0 16 | | 12 | | 03 |
| 3 | 95 | 2°00' | 94 08 | S 62°00' W | 1 40 | | 78 | | 127 |
| 4 | 115 | 1°20' | 114 97 | WEST | | | 78 | | 174 |
| 5 | 131 | 0°55' | 130 97 | S 86°00' W | 0 26 | | 80 | | 200 |
| 6 | 135 | 1°00' | 134 97 | S 79°00' W | 0 07 | | 81 | | 207 |
| 7 | 175 | 1°00' | 174 96 | S 77°00' W | 0 70 | | 97 | | 275 |
| 8 | 215 | 1°05' | 214 95 | N 71°00' E | 0 76 | | 72 | | 203 |
| 9 | 235 | 1°10' | 234 95 | S 81°00' W | 0 41 | | 78 | | 243 |
| 10 | 242 | 1°10' | 241 95 | S 42°00' E | 0 14 | | 88 | | 234 |
| | | | Closure | S 69°23' W | 2 50' | | | | |

APPENDIX L (continued)

Record of Aluminum Pipe Survey with Eastman Single Shot Survey Instrument

Camp 10B, upper Taku Glacier — Composite of February 11 and 17, 1951

| | Measured Depth | Drift Angle | True Verticle Depth | Drift Direction | Course Deviation | Rectangular Coordinates N | S | E | W |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 18 | 0°25' | 18 00 | N 87°00' E | 0 13 | 01 | | 13 | |
| 2 | 23 | 0°45' | 23 00 | S 87°00' E | 0 07 | 01 | | 20 | |
| 3 | 43 | 0°25' | 43 00 | S 25°00' E | 0 15 | | 13 | 26 | |
| 4 | 55 | 0°15' | 55 00 | S 38°00' W | 0 05 | | 17 | 23 | |
| 5 | 63 | 0°35' | 63 00 | S 57°00' W | 0 08 | | 21 | 16 | |
| 6 | 83 | 1°45' | 82 99 | S 75°00' W | 0 61 | | 37 | | 43 |
| 7 | 95 | 2°00' | 94 98 | S 62°00' W | 0 42 | | 57 | | 80 |
| 8 | 103 | 2°00' | 102 98 | S 45°00' W | 0 28 | | 77 | | 100 |
| 9 | 115 | 1°30' | 114 98 | N 82°00' W | 0 31 | | 73 | | 131 |
| 10 | 123 | 1°35' | 122 98 | N 87°00' W | 0 22 | | 72 | | 153 |
| 11 | 131 | 0°55' | 130 98 | S 86°00' W | 0 13 | | 73 | | 166 |
| 12 | 135 | 1°00' | 134 98 | S 79°00' W | 0 07 | | 74 | | 173 |
| 13 | 143 | 0°50' | 142 98 | S 86°00' W | 0 12 | | 75 | | 185 |
| 14 | 163 | 1°00' | 162 97 | S 84°00' W | 0 38 | | 79 | | 223 |
| 15 | 175 | 1°00' | 174 97 | S 77°00' W | 0 21 | | 84 | | 243 |
| 16 | 183 | 1°05' | 182 97 | S 74°00' W | 0 15 | | 88 | | 257 |
| 17 | 203 | 1°05' | 202 96 | N 21°00' E | 0 38 | | 53 | | 243 |
| 18 | 215 | 1°00' | 214 96 | N 70°00' E | 0 23 | | 45 | | 221 |
| 19 | 223 | 1°05' | 222 96 | S 10°00' W | 0 15 | | 60 | | 224 |
| 20 | 235 | 1°10' | 234 96 | S 81°00' W | 0 24 | | 64 | | 248 |
| 21 | 239 | 1°25' | 238 96 | S 52°00' E | 0 10 | | 70 | | 240 |
| 22 | 242 | 1°10' | 241 96 | S 42°00' E | 0 06 | | 74 | | 236 |
| 23 | 243 | 1°20' | 242 96 | S 46°00' E | 0 02 | | 75 | | 235 |
| | | 243' | Closure | S 72°18' W | 2 47' | | | | |
| 24 | 245* | 1°20' | 244 96 | S 46°00' W | 05 | | 78 | | 231 |
| | | 245' | Closure | S 71°21' W | 2 44 | | | | |

*Projected